LORAIN

POWER EQUIPMENT

INSTRUCTIONS

INSTALLATION

OPERATION

MAINTENANCE

RELIANCE COMM/TEC

LORAIN® MODEL HSB6H

DC - DC CONVERTER

SPEC. NO. 5664-025-00 SERIAL NO. _____

LORAIN PRODUCTS
Division of Reliance Electric Co.

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If the problem has been created by misuse or abuse of the equipment or by malfunction of associated equipment or by environmental conditions, at any time after shipment, the customer will be billed for circuit component and labor.

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NOTE

Part Numbering System

LORAIN is expanding its part numbering system by adding two additional numbers to the previous seven digit numbering system. All part numbers can be converted to the new system by adding -00 to the end of the old part number. As an example, Part No. 5438-008 becomes Part No. 5438-008-00 when changed to the new system. Because of conversion time, both types of numbering systems may appear in this instruction manual.

Document Changes/Revisions

LORAIN is also changing the method used to indicate changes and minor revisions to drawings. The previous system used a number to denote major changes and an alpha character for minor revisions, such as typographical errors. The new system uses an alpha character for major changes and a number for minor revisions. As an example, a drawing with an Issue 1B becomes Issue A2 with the new system. Again, because of conversion time, both systems may be used in this manual. The following table should be used as a guide to conversion to the new system:

A - 1	G - 7	N - 13	U - 19
B - 2	H - 8	P - 14	V - 20
C - 3	J - 9	Q - 15	W - 21
D - 4	K - 10	R - 16	X - 22
E - 5	L - 11	S - 17	Y - 23
F - 6	M - 12	T - 18	Z - 24

LORAIN® MODEL HSB6H DC-DC CONVERTER
SPEC. NO. 5664-025 AND 5664-027

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1. MODEL DATA

General

1.01 Refer to the Power Data sheet for information concerning input and output ratings, operating limits, dimensions, recommended input and output lead sizes, fusing, and terminal lug capacity for this DC to DC converter.

2. DESCRIPTION

General

2.01 This DC to DC converter operates from nominal 48 volt input to provide filtered and regulated 130 volts DC to the load. This converter is designed with a high frequency switching circuit to minimize audible noise levels.

2.02 This converter is equipped with high voltage shutdown and low voltage alarm circuits. Automatic converter shutdown results from a high output voltage condition. If a low output voltage condition occurs, the converter remains operational, but local and remote alarms are activated.

2.03 A low battery voltage sensing circuit inhibits converter operation and disables output to the load if input voltage decreases to 37 volts. The converter resumes operation automatically when input voltage increases to 42 volts.

2.04 This converter contains an output current limiting circuit which automatically limits its output current to a preset adjustable level.

3. INSTALLATION

Location

3.01 This DC to DC converter operates best in a well ventilated area with an ambient temperature range of 0°C (32°F) to 50°C (122°F).

Mounting

3.02 This converter is designed for mounting in 19 or 23 inch relay racks.

WARNING

In mounted position, ventilation openings at the top and bottom of the converter cabinet must be unobstructed. This is essential for proper cooling during operation. The temperature of air entering the cabinet must not exceed 50°C (122°F). Refer to Power Data sheet for spacing and baffle plate requirements.

Electrical Connections

3.03 Installer's input, output, and alarm connection terminals are accessible by removing the front cover of the unit. All terminals are located at the front right side of the unit. Installer connections are shown on the Power Data sheet.

a) Input Connections

1) Connect 48 VDC input at TB1, terminals + and -. Observe proper polarity. The negative input lead should be fused externally according to the recommendations in the Power Data sheet.

2) A jumper wire connects the positive (+) terminal of TB1 to the frame ground (FR GND) terminal. If desired, this jumper can be removed after installation.

b) Output Connections. Connect output leads to the load at TB2, terminals + and -. Observe proper polarity.

c) Output Polarity Connections. Three strapping connections at terminals 5 through 10, located immediately to the right of TB1 and TB2, determine the output polarity of this converter. These connections must be made according to the following procedure before the converter is placed in operation.

1) Positive Output (Ⓨ Option)

a. Connect one strap between terminals 5 and 9.

b. Connect the second strap between terminals 6 and 8.

c. Connect the third strap between terminals 7 and 10. Insure that all terminal screws are securely tightened.

2) Negative Output (Ⓩ Option)

a. Connect one strap between terminals 5 and 7.

b. Connect the second strap between terminals 6 and 10.

c. Connect the third strap between terminals 8 and 9. Insure that all terminal screws are securely tightened.

4. ADJUSTMENT

General

4.01 All control potentiometers are located on the main control circuit card in the converter, and become accessible after removal of the cover. Of all the potentiometers located on the circuit card, only three are intended for user adjustment. Procedures for adjusting output voltage, the high voltage shutdown value, and the low voltage alarm value are given in this section of the manual, and only these adjustments should be attempted by the user. Do not attempt to perform any adjustments not described in this section. Disturbing the settings of any factory-adjusted potentiometers will result in degraded equipment performance or complete failure. The equipment required for adjustment is listed as follows:

Test Equipment	Description
Digital Multimeter	Fluke Model 8022A or equivalent
Alignment Tool	GC Electronics type 8728A or equivalent

DANGER

All adjustments are performed while the converter is operating. Hazardous voltages capable of producing severe electrical shock may be present at the OUTPUT terminals (TB2) and at the OUTPUT POLARITY terminals. Exercise caution that contact is not made with any electrical termination, especially when connecting meter test probes. Remove watches, rings, and other jewelry before connecting test instruments and making adjustments. To further avoid the possibility of electrical shock or damage to the equipment, use only the insulated alignment tool recommended in the test equipment list when adjusting potentiometers.

Output Voltage Adjustment

4.02 Remove the front cover from the converter and observe the following procedure when adjusting output voltage.

a) Output voltage can be monitored on the front panel voltmeter of the converter. If desired, the test probes of a digital multimeter (DMM) can be connected at the OUTPUT terminals of TB2. Observe proper polarity.

b) With the converter operating, check the output current indicated by the front panel ammeter. Insure that output current does not exceed the full load rating of the converter.

c) Locate potentiometer R59 on the control circuit card as shown in Figure 4-1. Adjust this potentiometer clockwise for increased output voltage or counterclockwise for decreased output voltage.

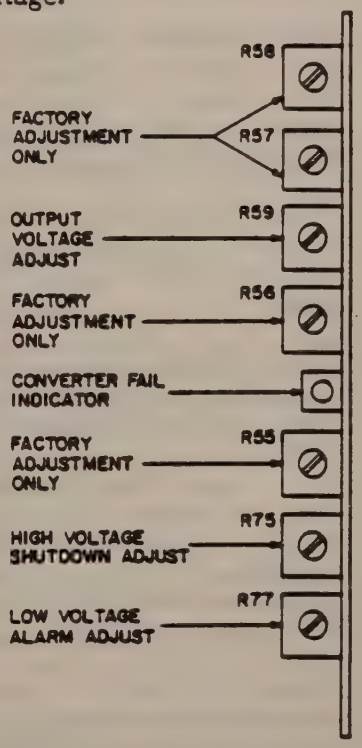


Figure 4-1. Adjustment Potentiometer Locations

d) When adjustment is completed, disconnect DMM test probes and replace the cover on the converter cabinet.

High Voltage Shutdown Adjustment

4.03 Remove the front cover from the converter and observe the following procedure when adjusting the high voltage shutdown limit. Unless otherwise specified, the factory adjusted value is 136.5 ± 0.5 volts.

CAUTION

Performing this procedure results in higher than normal output voltage from the converter and also interrupts power to the load when the shutdown level is set.

a) Adjust the DMM to monitor converter output voltage, and connect the test probes to the OUTPUT terminals of TB2. Observe proper polarity.

b) Adjust potentiometer R75, shown in Figure 4-1, fully clockwise.

c) Note the output voltage value indicated by the DMM. Adjust potentiometer R59, shown in Figure 4-1, for the output voltage value which equals the desired shutdown level.

d) Adjust potentiometer R75, shown in Figure 4-1, slowly counterclockwise until the INPUT circuit breaker trips open.

e) Adjust potentiometer R59 counterclockwise approximately 1/4-turn, then place the INPUT circuit breaker to the ON position.

f) Note the output voltage indicated by the DMM while slowly adjusting R59 clockwise. Continue turning the adjusting screw of R59 until shutdown occurs, and note the shutdown voltage level.

g) If the shutdown voltage level is satisfactory, no further adjustment is required. If the desired voltage level does not fall within the ± 0.5 volt tolerance limits, minor readjustment of R75 and repetition of Steps e) and f) are required.

h) When the desired shutdown level is attained, repeat Step e) and adjust potentiometer R59 for the output voltage value originally noted.

i) When all adjustments are completed, disconnect the DMM test probes and replace the converter cover.

Low Voltage Alarm Adjustment

4.04 Remove the front cover from the converter and observe the following procedure when adjusting the low voltage alarm limit. Unless otherwise specified, the factory adjusted value is 123.5 ± 0.5 volts.

CAUTION

Performing this procedure results in lower than normal output voltage from the converter. Insure that the load can tolerate a low voltage condition without adverse effects before performing the following adjustments.

a) Adjust the DMM to monitor converter output voltage, and connect the test probes to the OUTPUT terminals of TB2. Observe proper polarity.

b) Adjust potentiometer R77, shown in Figure 4-1, fully counterclockwise.

c) Note the output voltage value indicated by the DMM. Adjust potentiometer R59, shown in Figure 4-1, for the output voltage value which equals the desired low voltage alarm value.

d) Adjust potentiometer R77, shown in Figure 4-1, slowly clockwise until the CONVERTER FAIL indicator illuminates.

e) Adjust potentiometer R59 clockwise approximately 1/4-turn. The CONVERTER FAIL indicator should be extinguished.

f) Note the output voltage indicated by the DMM while slowly adjusting R59 counterclockwise. Continue turning the adjusting screw of R59 until the CONVERTER FAIL indicator illuminates, then note the alarm voltage level.

g) If the alarm voltage level is satisfactory, no further adjustment is required. If the desired voltage level does not fall within the ± 0.5 volt tolerance limits, minor readjustment of R77 and repetition of Steps e) and f) are required.

h) When the desired alarm level is attained, adjust potentiometer R59 for the output voltage value originally noted.

i) When all adjustments are completed, disconnect the DMM test probes and replace the converter cover.

5. OPERATION

General

5.01 This DC to DC converter operates from nominal 48 volts DC to provide filtered and regulated 130 volts DC to the load. An output wiring option allows the user to select either positive or negative output. Very little if any operator intervention is necessary after installation. Periodic maintenance and adjustments are not required.

Starting and Stopping

5.02 To start or stop converter operation, place the INPUT circuit breaker to the ON or OFF position, respectively. The circuit breaker is located on the front panel directly below the meters.

Metering

5.03 This DC to DC converter is equipped with an output voltmeter (M1) and ammeter (M2) which indicate output voltage and current, respectively.

Local Alarms

5.04 CONVERTER FAIL: Indicator CONVERTER FAIL (LED1) illuminates during a high voltage shutdown, low voltage alarm, low battery inhibit, or converter output failure.

Remote Alarms

5.05 High Voltage Shutdown and Low Battery Inhibit: Terminals 3 to 4 and 5 to 6 provide closed circuits while positive battery is provided at terminals 1 and 2 of TB3 during a shutdown or inhibit condition. The INPUT circuit breaker must be reset manually by placing it in the ON position to resume operation following a high voltage shutdown. The converter resumes operation automatically following a low battery inhibit condition when input voltage increases to at least 42 volts.

5.06 Low Voltage Alarm: Terminals 3 to 4 and 5 to 6 provide closed circuits while positive battery is provided at terminals 1 and 2 of terminal block TB3 during a low voltage alarm condition.

Fuses

5.07 The converter contains one output fuse. If replacement is required, use only Bussmann type BAF10, or equivalent.

Circuit Cards

5.08 This converter contains control circuit card A2, part no. 4864-248, replaceable in an edge connector. This circuit card is accessible after removing the front cover from the converter cabinet.

6. CIRCUIT DESCRIPTION

General

6.01 The Model HSB6H DC to DC Converter uses pulse width modulation (PWM) techniques for power control, and provides regulated, filtered 130 volts DC output of either positive or negative polarity. The major circuits comprising the converter are shown in block diagram form in Figure 6-1.

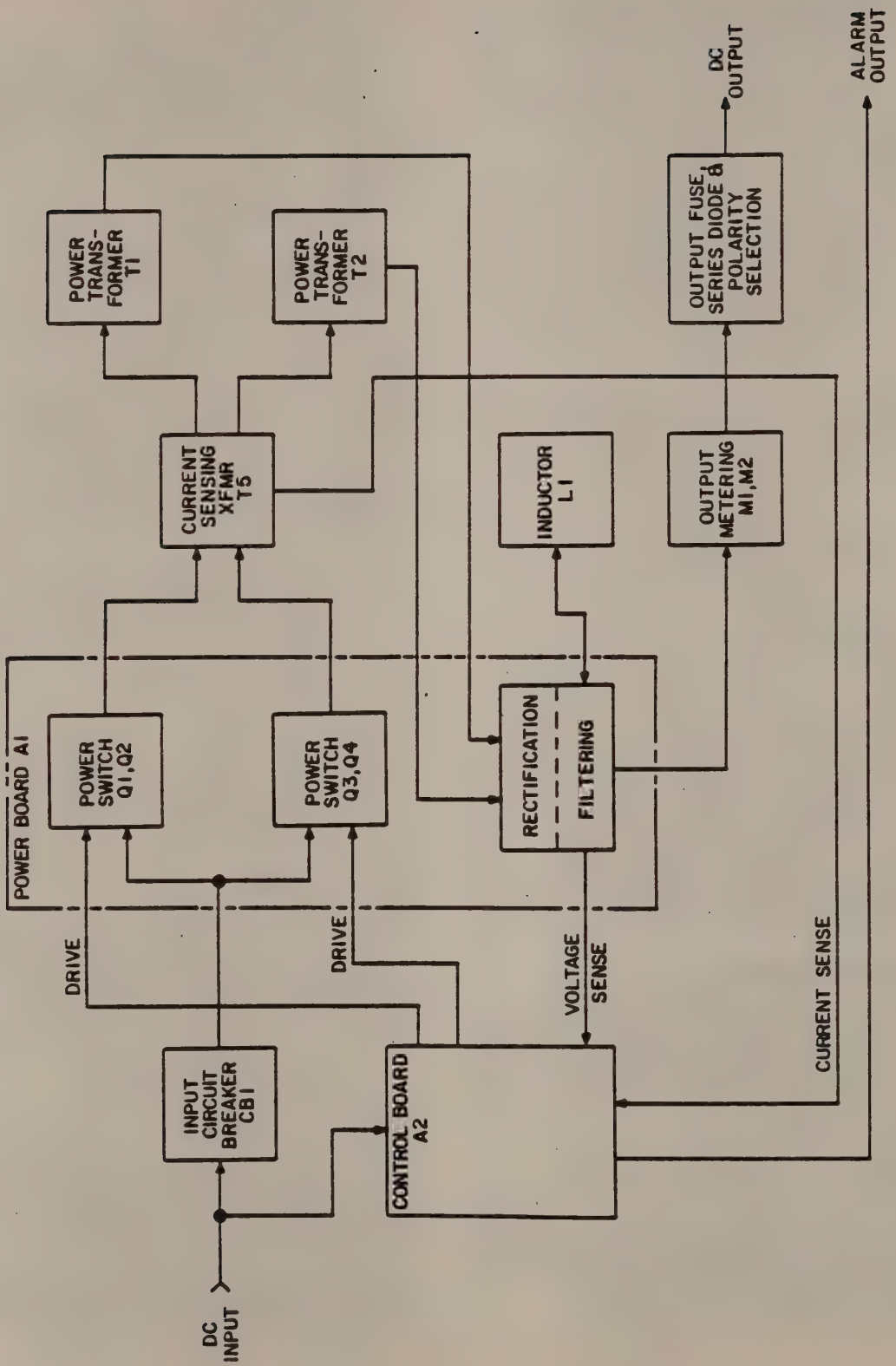


Figure 6-1. Block Diagram; Model HSB6H DC-DC Converter

DC Input Circuit

6.02 Battery power at TB1 is applied to circuit breaker CB1 which serves as a DC disconnect device for the power switching circuit. Unswitched negative battery is applied to control board A2 through connector P1-B for indicator CONVERTER FAIL operation.

Power Switching Circuit

6.03 The power switching circuit consists of two identical switching circuits on power board A1. These circuits, operating with power transformers T1 and T4, convert the DC input into an AC square wave under control of the drive circuits on control board A2. Two separate square wave drive signals, generated in the control circuits, are applied to transformers T2 and T3. These drive signals are displaced in phase by a certain number of electrical degrees; therefore, the two switching circuits cannot conduct at the same time. Since the two switching circuits are identical, only one is described and may be regarded as typical.

6.04 The square wave drive signal applied to the primary winding of transformer T2 is coupled into the base-emitter circuit of Q1 and Q2 through secondary winding 9 to 10. During the time the drive signal is positive with respect to common, transistors Q1 and Q2 are biased into conduction. During this period, current flows through the 1 to 2 winding of power transformer T1. When drive signal transition occurs, the square wave applied to transformer T2 drops from peak positive level to common. Simultaneously, current flow ceases through the 1 to 2 winding of power transformer T1.

6.05 The same kind of switching action occurs in transistors Q3 and Q4 and associated components. These transistors control current flow through the primary winding of power transformer T4. In each transformer, a voltage square wave is developed across the windings and is magnetically coupled to the secondary windings. The ratio of on time to off time and the phase displacement between the two drive signals coupled by T2 and T3 determines the power developed in transformers T1 and T4. This regulation method maintains constant output voltage from the converter despite input voltage and load current variations.

Rectification and Output Circuit

6.06 The rectification and filtering circuits are contained on circuit card A2. Secondary voltage developed in power transformers T1 and T4 is rectified by CR13 and part of CR14. The pulsating DC is applied to filter inductor L1 through terminals J8-1 and J8-2. Capacitors C5 and C6 form part of the filtering network. The filtered DC output is applied to the metering circuit, containing voltmeter M1 and ammeter M2, through terminals J9-1 and J9-2. Output DC is made available to the load at TB2 through the polarity selection circuit containing series diode CR1 and output fuse F1.

Control Circuits

6.07 The control circuits, contained on circuit card A2, sense output voltage and current, generate the drive signals for the power switching circuit, and generate required alarm and shutdown signals. This circuit card also contains an on-board power supply which provides operating power to all control components. The function of each circuit is explained in detail in the following paragraphs.

6.08 Power Supply. The power supply on circuit card A2 provides +12 VDC to all components of the control circuit. Battery voltage, applied at terminals P1-7 and P1-8, provides input power to the circuit when the input circuit breaker is closed. Resistor R1 and zener diode CR1 form a regulated 12 volt supply for integrated circuit A7 which operates as a synchronized multivibrator. At the moment of converter startup, A7 operates at its free-running frequency determined by R2, R3, and C12 since no synchronizing signal is yet available from pulse width modulator A2. The output square wave from A7 is applied through diode CR18 to transistor Q1 which operates as a switching amplifier. The collector of Q1 is directly coupled to the base of Q3 which is alternately driven into saturation and cutoff

so current flows through the 1 to 2 winding of trnsformer T1 at the frequency determined by A7. The voltage square wave developed across the 5 to 6 winding of T1 is rectified by CR20, with the resultant pulsating DC filtered by L1 and C2. This unregulated DC is applied to three-terminal voltage regulator A1 through CR31. The output of A1, filtered and bypassed by C5, is +12 volts DC made available to all control circuit components.

6.09 When the converter circuits become fully operational following startup, a synchronizing signal generated by A2 through the main power transformer is applied to current transformer T2 so the frequencies of both A2 and A7 are exactly the same. During normal converter operation, separate windings of power transformers T1 and T4 supply input AC at terminals P1-P, P1-S, and P1-R of circuit card A2. The input AC is rectified by CR28 and CR29 with the resultant DC filtered by L2 and C3. The filtered DC applied to A1 through CR32 is slightly higher in voltage than that DC applied to CR31. Once the converter is fully operational, the main power circuits supply input power to the +12 VDC supply on circuit card A2, thereby limiting power dissipation in A7, Q1, Q3, and associated components.

Startup Circuit

6.10 A soft-start circuit consisting of Q21, C9, and associated components prevents rapid application of power to the load when the converter is started. At the moment of converter startup, Q21 and associated components provide a high level DC signal of approximately 12 volts through CR14 to the control input of A2 at pin 6. Capacitor C9 charges at a controlled rate reducing the DC signal level to pin 6 of A2. As C9 charges, the output drive signal pulse width gradually widens so that available output power developed in the primary windings of power transformers T1 and T4, controlled by the power switching circuit, gradually increases from an initial low level. After C9 is fully charged, the DC control signal applied to A2 is sufficiently diminished so it has no further effect.

Pulse Width Modulator

6.11 The pulse width modulator circuit consists of integrated circuit A2, controlled by the output voltage and current limit control circuits. The basic operating frequency of A2 is determined by R39, R55, and C13. Since R55 is a potentiometer, the operating frequency can be adjusted within certain limits. The outputs from pins 11 and 13 of A2 are two variable duty cycle square waves used as drive signals by the power switching circuit. These outputs are displaced in phase by a certain number of electrical degrees, determined by the setting of potentiometer R56 in conjunction with the fixed values of R37 and R38. The control voltage applied to pin 6 of A2 affects the output duty cycle such that a more positive signal decreases the duty cycle.

Output Voltage Control

6.12 The output voltage of the converter is controlled by a voltage regulator circuit comprising operational amplifier A3 and associated components. Sampled output voltage, connected to circuit card A2 at terminal P1-V, is applied to a voltage divider network consisting of R62, R63, and R85. A portion of the sampled output voltage is applied to pin 5 of A3, used as an error amplifier, through R93. Amplifier A3 compares the sampled output voltage against a reference voltage derived from pin 14 of voltage follower A3. A portion of this reference voltage, determined by the setting of R59, is applied to pin 6 of A3 through R64. Any difference between the voltage values applied at pins 5 and 6 of A3 is amplified and appears at output pin 7 of A3. This amplified error signal is used as a control voltage at input pin 6 of A2. The control voltage is of proper polarity and amplitude to either increase or decrease the drive signal pulse width as required for input voltage, output voltage and load conditions, and the setting of potentiometer R59. The resulting increase or decrease of power level in the switching circuits and associated power transformers maintains the converter output voltage at a constant level.

Current Limit Control

6.13 Total current flowing through the windings of power transformers T1 and T4 is sensed by current transformer T5. The AC signal developed across the windings of T5 is applied to circuit card A2 at terminals P1-16 through P1-18, and rectified by CR16 and CR17. The resulting DC voltage is applied to peak charging capacitor C11 which converts the pulsating DC into a nearly pure DC voltage which changes in value according to current flow in T1 and T4. This DC voltage, used as a current information signal, is applied to pin 10 of A3. A portion of the reference voltage developed by voltage follower A3 is applied to pin 9 of A3 through R48 and the wiper contact of potentiometer R58. When the voltage level of the current information signal on pin 10 exceeds the reference voltage level on pin 9, amplifier A3 provides an output on pin 8. This control voltage output, applied to pin 6 of A2 through CR15, is of slightly higher value than the voltage regulator error voltage only when an overload condition occurs at the converter output. This current limit control signal applied to A2 results in a decrease of drive signal duty cycle which decreases current flow in the windings of T1 and T4, limiting current to a safe value. The current limit control signal reverts to normal value when the overload condition is cleared, allowing the output from the voltage regulator circuit to regain control of A2 for normal operation.

Low Battery Shutdown Circuit

6.14 The low battery shutdown circuit inhibits converter operation if DC input voltage decreases to a predetermined level. This circuit protects converter components from overcurrent damage which can occur at reduced input voltage levels. One of the amplifier segments of A3 is used as a comparator with a reference input at pin 2 and a battery voltage sensing input, derived from the +12 volt supply on circuit card A2, at pin 3. The sensing input is derived from the unregulated DC generated by the on-board +12 volt supply; therefore, as input voltage decreases, the sensing input level decreases. During normal circuit operation, the voltage level at pin 3 of A3 exceeds that applied to pin 2 so the output at pin 1 of A3 is a high level control signal which enables operation of pulse width modulator A2. If input voltage decreases to the point that the voltage on pin 3 of A3 is just slightly less than the reference voltage applied to pin 2, determined by the setting of potentiometer R57, the output at pin 1 of A3 switches to a low level to inhibit operation of A2. Resistor R42 provides hysteresis for A3 so battery voltage must increase above shutdown level before the inhibit signal is removed from pin 15 of A2. Inhibit signal removal occurs automatically when battery voltage increases to the proper value.

Drive Circuits

6.15 The drive circuits interface pulse width modulator A2 with the power switching circuits. Since two identical drive circuits are used, the operation of one circuit is explained in the following paragraphs. For purposes of explanation, the drive signal output from pin 11 of A2 is used. The only difference occurring in actual circuit operation is that the two drive signals from pins 11 and 13 of A2 are displaced in phase by a certain number of electrical degrees.

6.16 Assume initially that the output from pin 11 of A2 is in its high (+12 volt) state. During this time, CR3 is reverse biased allowing application of forward bias to Q15. As Q15 conducts, the junction of R17 and the base of Q13 is pulled to a low level. This allows Q13 to conduct while reverse biasing the base of both Q14 and Q16. Since Q13 is biased into conduction, current flows through the 7 to 8 winding of drive transformer T2 on circuit card A1, thus resetting this transformer for the next drive signal transition.

6.17 When output transition from high to low (zero volt) state occurs at pin 11 of A2, diode CR3 is forward biased. The resulting current flow biases Q15 into cutoff which, in turn, reverse biases the base of Q13. With Q13 biased into cutoff, current flow ceases through the 7 to 8 winding of drive transformer T2. Simultaneously, bias current for Q16 flows through resistors R17 and R20 which biases Q16 into conduction. As Q16 conducts, the base of Q14 is pulled to a low level

which biases this transistor into conduction. Current flows through Q14 and the 3 to 4 winding of drive transformer T2. Circuit conditions return to the original state at the next output transition from pin 11 of A2. The resulting voltage developed across the 3 to 4 winding of the drive transformer is magnetically coupled to the secondary winding which controls conduction of the power switching circuit transistors.

Alarm and Shutdown Circuits

6.18 Low Voltage Alarm. The low voltage alarm circuit continuously monitors converter output voltage and activates both local and remote alarms if output voltage decreases below a preset level. Sampled output voltage is applied to circuit card A2 at terminal P1-T, and is applied to pin 4 of operational amplifier A4 through resistor R81. Amplifier A4 is used as a comparator wherein the sampled output voltage is compared to a reference voltage provided by R79 and zener diode CR22. A portion of this reference voltage is applied to pin 5 of A4 through the wiper contact of potentiometer R77 and resistor R60. During normal converter operation the voltage level at pin 4 of A4 is higher than that level at pin 5. Amplifier A4 functions as a current sink which forward biases the light emitting diode (LED) in optical isolator A5. The paired transistor in A5 is driven into saturation which applies reverse bias to the base of Q22. With Q22 biased into cutoff, Q23 is biased into saturation through resistors R71 and R72. Current flows through the collector-emitter junction of Q23 and through the coil of K1.

6.19 If converter output voltage decreases sufficiently, the voltage level at pin 4 of A4 becomes lower than that level at pin 5. Amplifier A4 then functions as a current source, removing the forward bias from the LED in optical isolator A5. The paired transistor in A5 is then driven into cutoff, allowing forward bias to be applied to the base of Q22 through resistor R73. With Q22 driven into saturation, forward bias is removed from Q23 and current flow ceases through the coil of relay K1. The associated closed contacts allow the CONVERTER FAIL indicator to illuminate and provide external alarm circuits.

6.20 High Voltage Shutdown. The high voltage shutdown circuit continuously monitors converter output voltage and automatically trips open the DC input circuit breaker if output voltage increases above a preset level. Sampled output voltage, connected to circuit card A2 at terminal P1-T, is applied to pin 6 of operational amplifier A4 through resistor R81. Amplifier A4 is used as a comparator wherein the sampled output voltage is compared to a reference voltage provided by R79 and zener diode CR22. A portion of this reference voltage is applied to pin 7 of A4 through the wiper contact of potentiometer R75 and resistor R86. During normal converter operation, the voltage level at pin 7 of A4 is higher than that level at pin 6. Amplifier A4 functions as a current source to prevent application of forward bias to the LED in optical isolator A6. The paired transistor in A6 is biased into cutoff which maintains both Q4 and Q5 in a cutoff state. Current cannot flow through the emitter-collector junction of Q4 so the trip coil of CB1, connected to circuit card A2 at terminal P1-K, is not energized.

6.21 If converter output voltage increases sufficiently, the voltage level at pin 6 of A4 becomes higher than that level at pin 7. Amplifier A4 then functions as a current sink, applying forward bias to the LED in optical isolator A6. The paired transistor in A6 is driven into saturation which applies forward bias to the base of Q5. The conduction of Q5 allows application of forward bias to the base of Q4 which energizes the trip coil in CB1. When the input circuit breaker trips open, automatic converter shutdown occurs to protect the load against a high voltage condition.

7. TROUBLESHOOTING

Introduction

7.01 The troubleshooting information in this section should be used as a guide in localizing failures in the converter. Before attempting any troubleshooting procedures, the converter should be disconnected from the load and isolated from any other power equipment. In doing so, the converter is isolated from any external equipment failures which may reflect as a trouble symptom.

DANGER

Unless otherwise specified, troubleshooting procedures should be undertaken only after the DC power source to the converter has been disconnected. Service personnel should observe all precautions normally associated with maintenance and repair of electronic and power conversion equipment.

Fault Isolation Chart Use

7.02 The fault isolation chart included in these instructions is designed to aid service personnel in locating possible failures in the converter. The chart is in the form of a flow diagram containing interrogatory and directive statements in diamond-shaped and rectangular geometric figures, respectively. A yes or no response sufficiently answers each inquiry, and the servicing technician should follow the respective YES or NO line of flow to the next inquiry or directive statement. The directive statements require that the technician perform an adjustment or test to verify certain operational conditions. If the line of flow terminates in a block entitled POSSIBLE CAUSES, the servicing technician should check each cause listed and take appropriate corrective action if a faulty component or assembly is located.

Repair and Replacement Information

DANGER

Insure that all power sources are fully disconnected from the converter before performing any repair or replacement procedures.

7.03 When a trouble symptom is localized to a faulty plug-in circuit card, that particular circuit card should be replaced in its entirety. No attempt should be made to troubleshoot or repair individual circuit cards. In these instructions, circuit card A1 will be treated as individual components since this circuit card is difficult to replace.

7.04 If the suspected cause of a trouble symptom is an out of adjustment condition, the particular adjustment setting should be checked or reset using the appropriate adjustment procedure.

7.05 Component failures are sometimes evident during a visual inspection of the circuit. Obvious trouble symptoms such as loose connections, overheated, discolored, or burned components, open fuses, or burned and melted wire insulation should be corrected and the cause determined before proceeding with more detailed maintenance procedures.

7.06 Various test procedures referenced on the fault isolation chart provide the servicing technician with suggested methods for testing certain circuit components. Whenever a numbered test procedure is encountered in the chart, service personnel should refer to that particular test procedure in this section for further troubleshooting information.

7.07 Semiconductor device outlines for diodes and transistors used in this converter are shown in Figure 7-1. The outlines are intended to aid servicing personnel in identifying semiconductor terminations during troubleshooting or replacement procedures.

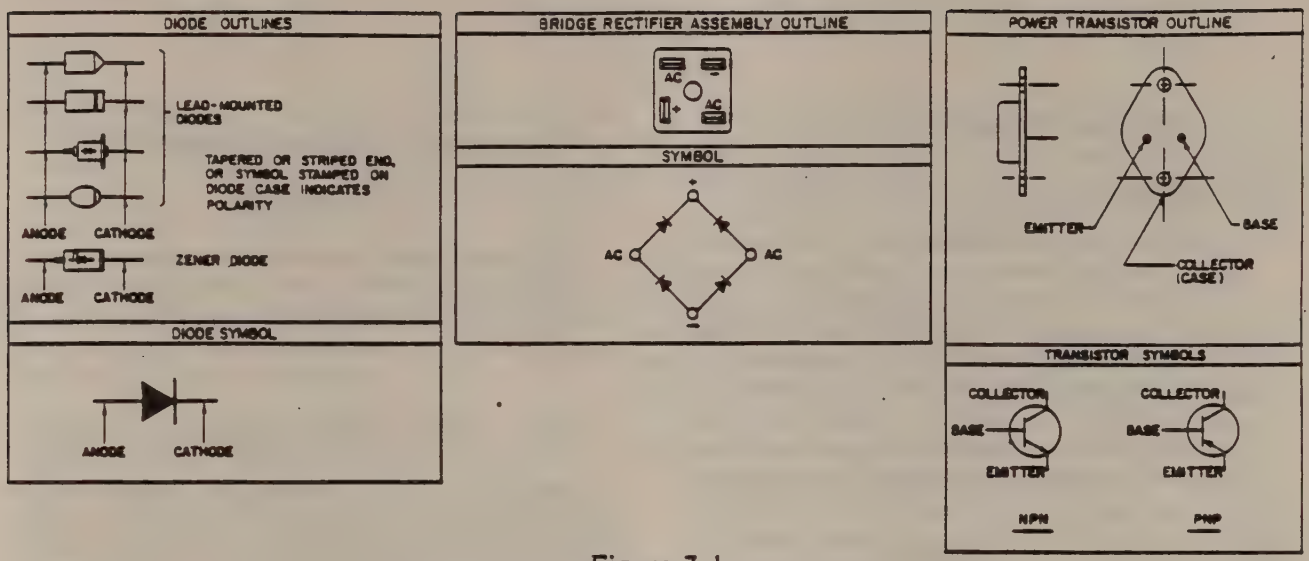


Figure 7-1
Semiconductor Identification Outlines

Test Procedures

7.08 The following test procedures are those referenced by number on the fault isolation chart. By following one of the appropriate procedures, the servicing technician can perform a test on components suspected of failure.

7.09 Test Equipment, Tools, and Materials: The following test equipment, tools, and materials are necessary to perform the procedures in this section:

Description	Model
Analog or Digital Multimeter	Triplett Model 630A, or equivalent (analog) Fluke Model 8022A, or equivalent (digital)
Flat Blade Screwdriver	
Torque Screwdriver: calibrated and set for 5-inch pounds	
Thermal Joint Compound	Thermalloy Type 120, or equivalent
*Ceramic Insulators for TO-3 Transistors	Lorain Part No. 2868-274

*needed only if originals are damaged

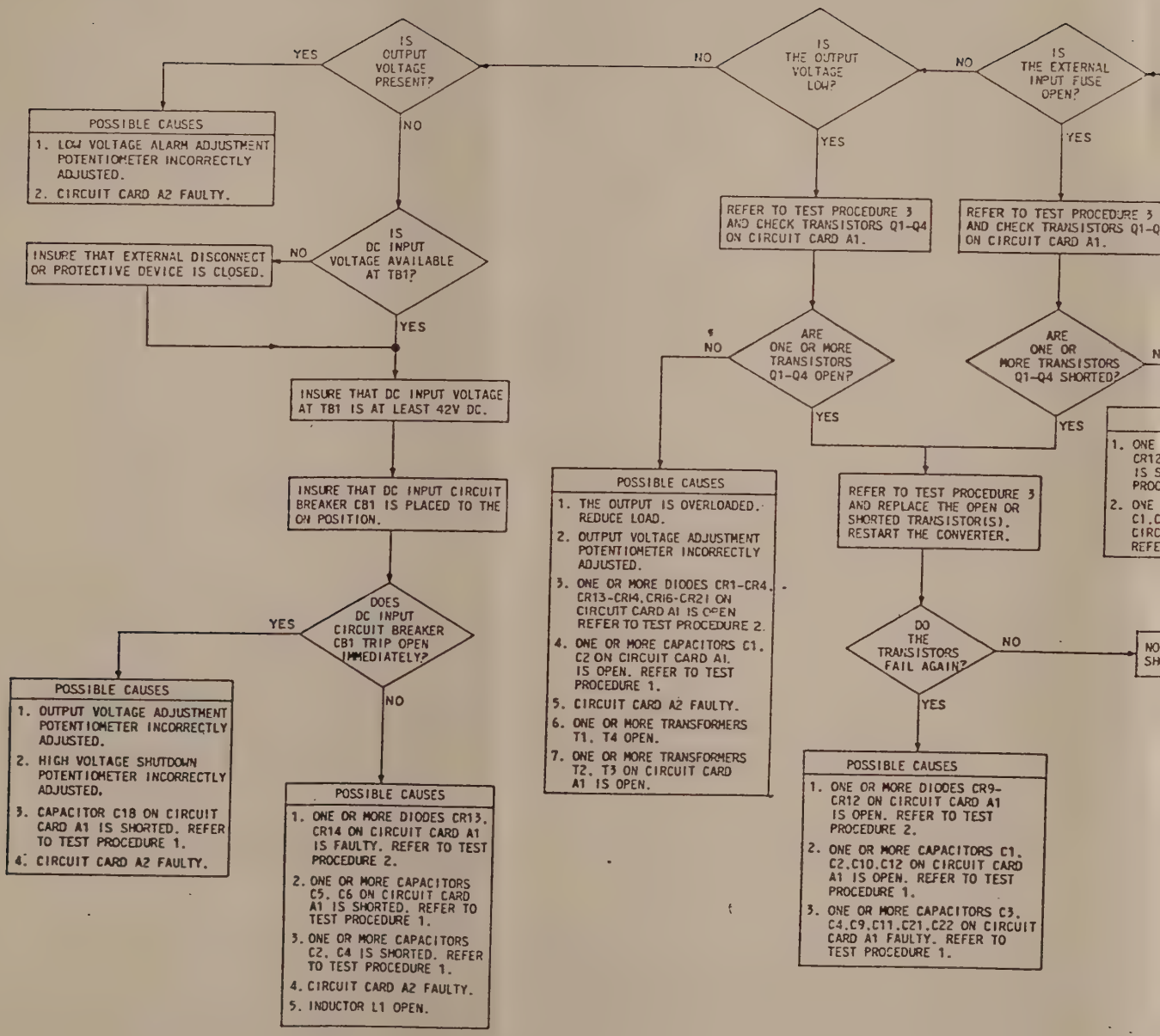
7.10 Test Procedure 1. Perform this test when checking a capacitor for opens or shorts.

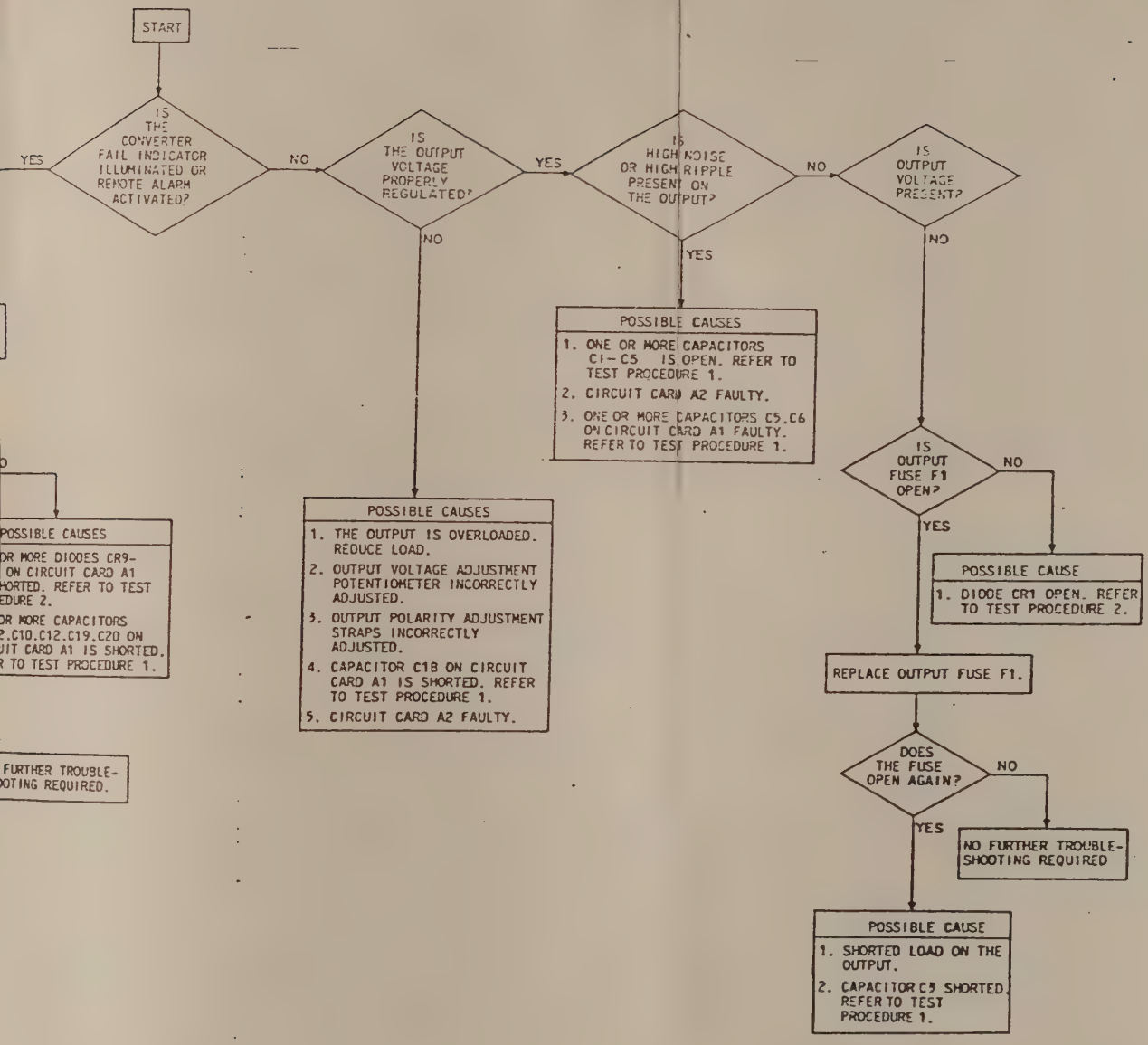
a) Turn off the converter. Insure that the DC power source is disconnected.

b) Allow at least 60-seconds to elapse from time of converter shutdown, then disconnect both leads or terminals of capacitor to be tested.

c) Set the multimeter for ohmmeter function, using a high resistance range.

d) Momentarily short the capacitor leads or terminals to insure complete discharge. Connect meter test leads to capacitor leads or terminals, and observe indicated resistance. For a good capacitor without any faults, initial resistance is low and gradually increases as capacitor takes a charge. Final resistance is usually several hundred thousand ohms, approaching 1 megohm. Initial high resistance approaching infinity indicates an open capacitor. Initial and continued low resistance near zero ohms indicates a shorted capacitor. Replace any capacitor which indicates an open or shorted condition.


IS OUTPUT VOLTAGE PRESENT?
YES
NO
POSSIBLE CAUSES
1. LOW VOLTAGE ALARM ADJUSTMENT POTENTIOMETER INCORRECTLY ADJUSTED.
2. CIRCUIT CARD A2 FAULTY.
IS DC INPUT VOLTAGE AVAILABLE AT TB1?
NO
INSURE THAT EXTERNAL DISCONNECT OR PROTECTIVE DEVICE IS CLOSED.
YES
INSURE THAT DC INPUT VOLTAGE AT TB1 IS AT LEAST 42V DC.
INSURE THAT DC INPUT CIRCUIT BREAKER CB1 IS PLACED TO THE ON POSITION.
DOES DC INPUT CIRCUIT BREAKER CB1 TRIP OPEN IMMEDIATELY?
YES
POSSIBLE CAUSES
1. OUTPUT VOLTAGE ADJUSTMENT POTENTIOMETER INCORRECTLY ADJUSTED.
2. HIGH VOLTAGE SHUTDOWN POTENTIOMETER INCORRECTLY ADJUSTED.
3. CAPACITOR C18 ON CIRCUIT CARD A1 IS SHORTED. REFER TO TEST PROCEDURE 1.
4. CIRCUIT CARD A2 FAULTY.
NO
POSSIBLE CAUSES
1. ONE OR MORE DIODES CR13, CR14 ON CIRCUIT CARD A1 IS FAULTY. REFER TO TEST PROCEDURE 2.
2. ONE OR MORE CAPACITORS C5, C6 ON CIRCUIT CARD A1 IS SHORTED. REFER TO TEST PROCEDURE 1.
3. ONE OR MORE CAPACITORS C2, C4 IS SHORTED. REFER TO TEST PROCEDURE 1.
4. CIRCUIT CARD A2 FAULTY.
5. INDUCTOR L1 OPEN.
IS THE OUTPUT VOLTAGE LOW?
NO
YES
REFER TO TEST PROCEDURE 3 AND CHECK TRANSISTORS Q1-Q4 ON CIRCUIT CARD A1.
ARE ONE OR MORE TRANSISTORS Q1-Q4 OPEN?
NO
YES
POSSIBLE CAUSES
1. THE OUTPUT IS OVERLOADED. REDUCE LOAD.
2. OUTPUT VOLTAGE ADJUSTMENT POTENTIOMETER INCORRECTLY ADJUSTED.
3. ONE OR MORE DIODES CR1-CR4, CR13-CR14, CR16-CR21 ON CIRCUIT CARD A1 IS OPEN REFER TO TEST PROCEDURE 2.
4. ONE OR MORE CAPACITORS C1, C2 ON CIRCUIT CARD A1 IS OPEN. REFER TO TEST PROCEDURE 1.
5. CIRCUIT CARD A2 FAULTY.
6. ONE OR MORE TRANSFORMERS T1, T4 OPEN.
7. ONE OR MORE TRANSFORMERS T2, T3 ON CIRCUIT CARD A1 IS OPEN.
IS THE EXTERNAL INPUT FUSE OPEN?
NO
YES
REFER TO TEST PROCEDURE 3 AND CHECK TRANSISTORS Q1-Q
ARE ONE OR MORE TRANSISTORS Q1-Q4 SHORTED?
YES
REFER TO TEST PROCEDURE 3 AND REPLACE THE OPEN OR SHORTED TRANSISTOR(S). RESTART THE CONVERTER.
DO THE TRANSISTORS FAIL AGAIN?
NO
YES
POSSIBLE CAUSES
1. ONE OR MORE DIODES CR9-CR12 ON CIRCUIT CARD A1 IS OPEN. REFER TO TEST PROCEDURE 2.
2. ONE OR MORE CAPACITORS C1, C2, C10, C12 ON CIRCUIT CARD A1 IS OPEN. REFER TO TEST PROCEDURE 1.
3. ONE OR MORE CAPACITORS C3, C4, C9, C11, C21, C22 ON CIRCUIT CARD A1 FAULTY. REFER TO TEST PROCEDURE 1.


START
IS THE CONVERTER FAIL INDICATOR ILLUMINATED OR REMOTE ALARM ACTIVATED?
YES
NO
IS THE OUTPUT VOLTAGE PROPERLY REGULATED?
YES
NO
IS HIGH NOISE OR HIGH RIPPLE PRESENT ON THE OUTPUT?
YES
NO
IS OUTPUT VOLTAGE PRESENT?
NO
POSSIBLE CAUSES
1. ONE OR MORE CAPACITORS C1 – C5 IS OPEN. REFER TO TEST PROCEDURE 1.
2. CIRCUIT CARD A2 FAULTY.
3. ONE OR MORE CAPACITORS C5,C6 ON CIRCUIT CARD A1 FAULTY. REFER TO TEST PROCEDURE 1.
POSSIBLE CAUSES
1. THE OUTPUT IS OVERLOADED. REDUCE LOAD.
2. OUTPUT VOLTAGE ADJUSTMENT POTENTIOMETER INCORRECTLY ADJUSTED.
3. OUTPUT POLARITY ADJUSTMENT STRAPS INCORRECTLY ADJUSTED.
4. CAPACITOR C18 ON CIRCUIT CARD A1 IS SHORTED. REFER TO TEST PROCEDURE 1.
5. CIRCUIT CARD A2 FAULTY.
IS OUTPUT FUSE F1 OPEN?
NO
YES
POSSIBLE CAUSE
1. DIODE CR1 OPEN. REFER TO TEST PROCEDURE 2.
REPLACE OUTPUT FUSE F1.
DOES THE FUSE OPEN AGAIN?
NO
YES
NO FURTHER TROUBLE-SHOOTING REQUIRED
POSSIBLE CAUSE
1. SHORTED LOAD ON THE OUTPUT.
2. CAPACITOR C5 SHORTED. REFER TO TEST PROCEDURE 1.

FAULT ISOLATION CHART

MODEL HSB6H SPEC. NO. 5664-025
SPEC. NO. 5664-027

OTES:

ALL COMPONENTS ARE LOCATED ON THE CONVERTER CHASSIS UNLESS OTHERWISE SPECIFIED.

CIRCUIT CARD A1 IS BACKPLANE BOARD MOUNTED TO CONVERTER CABINET.

CIRCUIT CARD A2 IS PLUG-IN REPLACEABLE BOARD

e) Perform Steps b) through d) on all capacitors suspected of being faulty.

f) When all tests are completed, insure that wiring to subject capacitors is properly connected.

g) If no further tests are required, return the converter to normal operation.

7.11 Test Procedure 2. Perform this test when checking a diode for opens or shorts.

a) Turn off the converter. Insure that the DC power source is disconnected.

b) Disconnect all wiring from one terminal of the diode to be tested.

c) Set the multimeter for ohmmeter function, using 2K resistance range.

d) Connect meter test leads to diode terminals, and note indicated resistance. Reverse test lead connections, and again note indicated resistance. A good diode without any faults indicates a low resistance, typically 0.7K ohms when forward biased, and nearly infinite resistance when reverse biased. A shorted diode typically indicates zero ohms regardless of test lead connections; conversely, an open diode indicates very high resistance regardless of test lead connections. Replace any diode which indicates an open or shorted condition.

e) Perform Steps b) through d) on all diodes suspected of being faulty.

f) When all tests are completed, insure that wiring to subject diodes is properly connected.

g) If no further tests are required, return the converter to normal operation.

7.12 Test Procedure 3. Perform this test when checking transistors Q1-Q4 for opens or shorts.

a) Turn off the converter. Insure that the DC power source is disconnected.

b) If furnished, remove the plastic shield to access the four power transistors, Q1-Q4, located on the rear of the converter chassis. Using a small flat blade screwdriver, remove two mounting screws from each of the four power transistors.

WARNING

A ceramic insulator is placed between each transistor and the heat sink surface. These insulators are as fragile as glass; therefore, use extreme care when removing the transistors in the next step.

c) Carefully remove the four power transistors from their sockets. Each ceramic insulator should remain on the mounting surface of each transistor to avoid damaging the insulators.

d) Check each of the transistors for opens or shorts by following the procedure below:

1) Set the multimeter to the ohmmeter function on the X10 ohm scale.

2) Connect the meter between the emitter and collector of the transistor, note the meter indication, then reverse the meter connections to the emitter and collector. The meter should indicate infinite resistance in either direction. Low or zero resistance in either direction is an indication that the transistor is faulty and should be replaced.

3) Connect the metér between the emitter and base of the transistor, note the meter indication, then reverse the meter connections to the emitter and base. The meter should indicate a low resistance (under 50 ohms) in one direction and a high resistance (over 100 ohms) in the other direction. If a short or open is indicated in either direction, replace the transistor.

4) Connect the meter between the collector and base of the transistor, note the meter indication, then reverse the meter connections to the collector and base. The meter should indicate a low resistance (under 50 ohms) in one direction and a high resistance (over 100 ohms) in the other direction. If a short or open is indicated in either direction, replace the transistor.

e) Apply thermal joint compound to any replacement transistors as indicated in the next step. If any transistor is replaced, the ceramic insulator from the open or shorted transistor must be mounted on to the replacement transistor.

f) Inspect the transistor mounting areas on the heat sink and the insulator mounting surfaces on the transistors. Each of these surfaces is coated with thermal joint compound and must not be contaminated with any dirt or particles of foreign substances. If inspection proves that some type of contamination is present, clean the surface completely and recoat with thermal joint compound.

WARNING

Thermal joint compound must be present between the transistor mounting surface, the insulator face adjacent to it, and between the heat sink surface and insulator face. A coating thickness of one-thousandth inch is sufficient; however, total lack of thermal joint compound will result in transistor failure.

g) After insuring mounting surface cleanliness, place the power transistors in their sockets. The same type of transistor is used in all locations; therefore, placement of transistors in any particular socket is not critical.

h) Replace the two mounting screws previously removed at each power transistor and socket. Tighten with fingers only.

WARNING

Insure that the proper mounting screws are used in securing each power transistor in its socket. Each screw is insulated with heat shrinkable tubing and contains a bronze internal tooth lockwasher. Only these screws may be used for transistor mounting. Under no circumstances may these screws be tightened with a standard screwdriver.

i) Using a torque screwdriver only which has been set and calibrated for 5 inch-pounds, tighten the power transistor mounting screws. Use of higher torque or a standard screwdriver may crack and thereby destroy the ceramic insulator beneath each transistor.

j) Replace the plastic shield over the power transistors if one was removed in Step b).

k) If no further tests are required, return the converter to normal operation.

APPENDIX

RECORD OF INSTRUCTION CHANGES		
ISSUE OR DATE	ECN	DESCRIPTION OF CHANGE
3	-	Spec. No. 5664-027 added.
4		Troubleshooting information added. Schematic drawings in Circuit Description Section removed. Table of Contents for Circuit Description Section updated.
5	183-8410	Para. 6.09 revised.

LORAIN PRODUCTS

1122 F Street, Lorain, Ohio 44052
(216) 288-1122/TRT: 196131 LORN UT/WUD: 980505 (LORN PROD LORN)

In Canada —
Reliance Telecommunication Products Ltd., 122 Edward St., St. Thomas, Ont.
TEL. 519-631-0780/TWX. 610-356-6703 (LORAIN PRODCAN)

In Mexico —
Productos Lorain de Mexico, S.A. de C.V., Apartado Postal 77001
TEL. 576-82-77/TLX./01774308 (1774308 LORME)

RELIANCE COMM/TEC

RECOMMENDED SPARE PARTS LIST
LORAIN MODEL HSB6H DC/DC CONVERTER
SPEC. NO. 5664-025-00

This Electrical Parts List is arranged alphabetically by part name. Spare parts are not usually required if adequate standby equipment is available and if the LORAIN equipment is installed at an accessible location so that parts can be readily obtained from Lorain Products stock. The ON-SITE quantity of spare parts will be sufficient for most repairs and should be sufficient for ten or less assemblies or models for at least 18 months. The Depot quantity is a more complete set of spare parts for remote areas or service for a number of sites. When ordering parts, please furnish equipment Model No., Spec. No., and Serial No. as given on the equipment nameplate.

LPC Part Number	Description	Quantity of Recm. Spares ON-SITE	Depot
ASSEMBLIES			
4864-247-00	Power Board PW Assy	1	1
4864-248-00	Control Board PW Assy	1	1
CAPACITOR			
2724-140-00	0.01UF 1000V	0	1
2724-160-00	680 PF 1000 VDC	0	1
CIRCUIT BREAKER			
2566-114-00	25A 32VDC	0	1
FUSE			
2483-430-00	10 Amp Cartridge	1	1
MAGNETIC UNITS			
4423-041-00	Current Transformer	0	1
4451-060-00	Power Transformer	0	1
4484-017-00	DC Filter Inductor	0	1
METERS			
2923-441-00	0-10A DC Ammeter	0	1
2943-431-00	0-150V DC Voltmeter	0	1

RECOMMENDED SPARE PARTS LIST
LORAIN MODEL HSB6H DC/DC CONVERTER
SPEC. NO. 5664-025-00

LPC Part Number	Description	Quantity of Recm. Spares ON-SITE	Depot
RESISTOR			
2651-319-00	Fixed, 100 OHM 3W	0	1
2652-563-00	Fixed, 15K Ohm 11W	0	1
SEMICONDUCTOR			
2821-839-00	Rectifier, 1 PH 30 A 600V	2	2
2822-030-00	Rectifier, 1 PH 25A 200V	2	2
MISCELLANEOUS			
2478-534-00	Housing, 2 CKT Socket	0	1
2478-542-00	Housing, 4 CKT	0	1
2478-781-00	Housing, 8 POS	0	1
2488-141-00	Fuseholder, 30A 600V	0	1

DD/cvb

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In Mexico —
Productos Lorain de Mexico, S.A. de C.V., Apartado Postal 77001
TEL. 576-82-77/TLX./01774308 (1774308 LORME)

RELIANCE COMM/TEC

1. SPECIFICATION

1.1 **GENERAL:** This DC to DC Converter changes 48 volts DC positive ground input to 130 volts DC output for either positive or negative grounded systems.

1.2 **OUTPUT RATINGS**

1.2.1 **Voltage:** Negative or positive 130 volts DC nominal. Adjustable over the range of 123.5 to 136.5 volts.

1.2.2 **Regulation**

(A) **Static:** Steady state output voltage remains within ±1% of the adjusted voltage for any load current from no load to full load over the input voltage range of 42 to 56 volts DC.

(B) **Dynamic:** For a step load change of 50% within the range of 10% to 100% of full rated current, the maximum voltage transient will not exceed 5% of the initial steady state voltage. Refer to Para. 1.7.1.

1.2.3 **Filtering**

(A) **Voice Band:** Noise is less than 26 dBrn C message. Refer to Para. 1.7.1.

(B) **Wide Band:** Does not exceed 1.3 volts peak to peak over the frequency range of 10 Hz to 50 MHz. Refer to Para. 1.7.1.

1.2.4 **Current:** 6 amperes

1.3 **INPUT RATINGS**

1.3.1 **Voltage:** 48 volts DC positive ground, with operational range of 42 to 56 volts DC. This converter will tolerate a range of 40 to 60 volts DC with no adverse effects.

1.3.2 **Typical Input Data**

DC Input Voltage	Input Amperes	Percent Load	Percent Efficiency
42	0.7 10.4 21.2	0 50 100	- 89.6 88.5
48	0.4 9.2 18.3	0 50 100	- 88.9 88.7
56	0.4 7.9 15.9	0 50 100	- 87.8 87.9

1.3.3 **Maximum Input Current:** Does not exceed 23.2 amperes at 110% load with input voltage of 42 VDC.

1.3.4 **Filtering:** Noise reflected into a 100 ampere hour battery is less than 26 dBrn. Refer to Para. 1.7.1.

ISSUE	CHG NO	DESCRIPTION
E1	—	AUG 28 1986 BP PARA 1.4.2 (C) REWORDED 8-28-86
D1	—	MAY 5 1986 BP PARA. 1.5.4 (C) STACKING REQUIREMENTS CLARIFIED DD 5-5-86
C1	183-9356	APR 3 1986 BP HEAT SINK ADDED 4-3-86
		CONVERSION TO LAMPS
2	—	Cable entrance hole and dimensions added on page 4. BP MAY 17 1982 5-17-82
1	—	NEW BP APR 5 1982 4-1-82

REVISIONS

LORAIN PRODUCTS
LORAIN, OHIO
RELIANCE COMM/TEC

POWER DATA

MODEL HSB6H DC TO DC CONVERTER
SPEC. NO. 5664-025-00

DR BY	DATE	GRP. LDR	DATE	
T. IVAN	2-23-82	D.J. Burden	3/22/82	PD5664-025-00
CH BY	DATE	APP BY	DATE	
		G.J. Filone	3-23-82	
ENGR BY	DATE			PAGE 1 OF 6
G. Georgalis	2-24-82			

1. SPECIFICATION

1.4 STANDARD FEATURES

1.4.1 Input Protection

(A) DC input circuit breaker opens the negative input lead. This input lead should be fused externally according to the recommendation of INSTALLER'S INFORMATION NOTE 4.1.

(B) Low battery voltage sensing circuit automatically inhibits converter operation if input voltage decreases to 37 volts. Converter operation resumes automatically when input voltage increases above 42 volts.

1.4.2 Output Protection

(A) **Short Circuit:** One 10 ampere fuse, Bussmann type BAF or equivalent

(B) **Current Limiting:** At nominal input voltage, output current is automatically limited to 110% of full load rating.

(C) **Overvoltage:** The high voltage shutdown setting should be a minimum of 6.5 volts above the output voltage setting to prevent nuisance shutdowns due to load transients.

1.4.3 Audible Noise: Operating frequency beyond audible range.

1.4.4 Meters:

(A) 0-150 volt, 2-1/2 inch rectangular type DC voltmeter, ± 2% accuracy of full scale, 2.41 inch scale length.

(B) 0-10 ampere, 2-1/2 inch rectangular type DC ammeter, ± 2% accuracy, 2.41 inch scale length.

1.4.5 Series Output Diode: Series output diode, which enables paralleling with other converters, is connected in either negative or positive output lead, depending on output polarity chosen. Load may not be shared proportionally between parallel connected units.

1.4.6 Converter Fail Alarm: Upon occurrence of any of the following failure or operational conditions, indicator CONVERTER FAIL illuminates, two closed loop alarm circuits are available at TB3 terminals 3 to 4 and 5 to 6, and two extended ground alarm circuits are available at TB3 terminals 1 and 2:

(A) Output voltage exceeds a preset limit, factory adjusted at 136.5 ±0.5 volts, causing automatic converter shutdown.

(B) Output voltage decreases below a preset limit, factory adjusted at 123.5 ±0.5 volts.

(C) Input voltage decreases below the factory set limit of 37 volts, which causes automatic inhibiting of converter operation.

(D) The converter is turned off manually.

1.4.7 Mounting: Universal angle provided for either 19 inch (1-3/4 inch multiple drilling) or 23 inch (1 inch or 1-3/4 inch multiple drilling) relay rack mounting.

1.5 ENVIRONMENTAL RATINGS

1.5.1 Operating Ambient Temperature Range: 0 °C to +50 °C (+32 °F to +122 °F)

1.5.2 Storage Temperature Range: -20 °C to +65 °C (-4 °F to +149 °F)

1.5.3 Heat Dissipation: 338 Btu/hr (48 volt input at 130 volt output and full load)

1. SPECIFICATION

1.5 ENVIRONMENTAL RATINGS (Cont'd)

1.5.4 Ventilation Requirements

(A) **Ventilation:** This converter should be mounted so bottom and top ventilating openings are not blocked and temperature of the air entering the bottom of the cabinet does not exceed +50°C (+122°F).

(B) **Spacing:** It may be necessary to allow a minimum of 1 3/4" spacing between this converter and other heat producing equipment.

(C) **Stacking:** A maximum of two converters may be stacked, one above the other, with 1-3/4 inch minimum spacing. A 1-3/4 inch baffle plate must be used to separate the pair of converters from other heat producing equipment.

1.6 MISCELLANEOUS

1.6.1 **Schematic Diagram:** SD-5664-025-00

1.6.2 **Wiring Diagram:** T-5664-025-00

1.6.3 **Instructions:** Section 4243

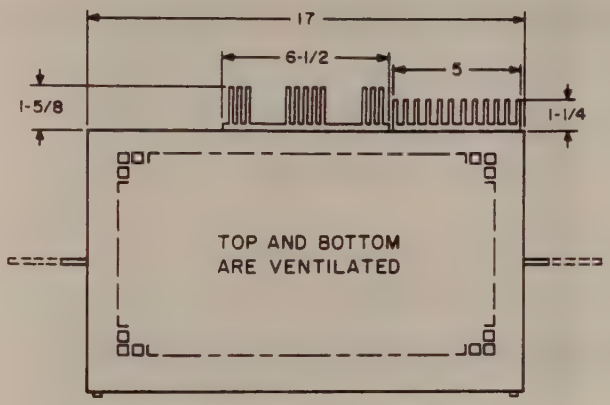
1.7 SPECIFICATION NOTES

1.7.1 This parameter is guaranteed by Engineering Design and test. Parameter is not production tested.

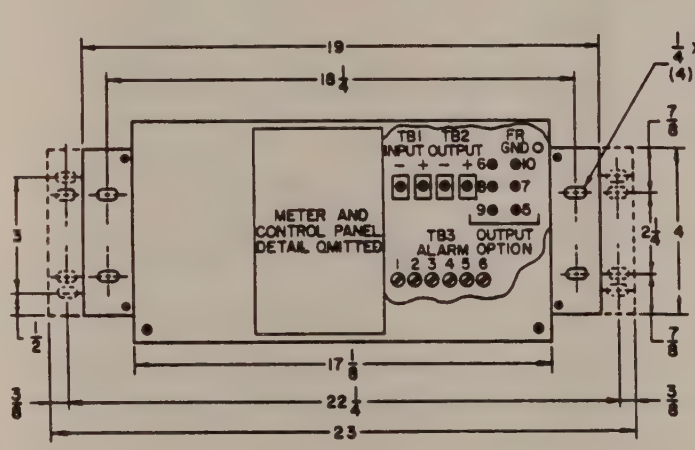
2. DIMENSIONS

NOTES

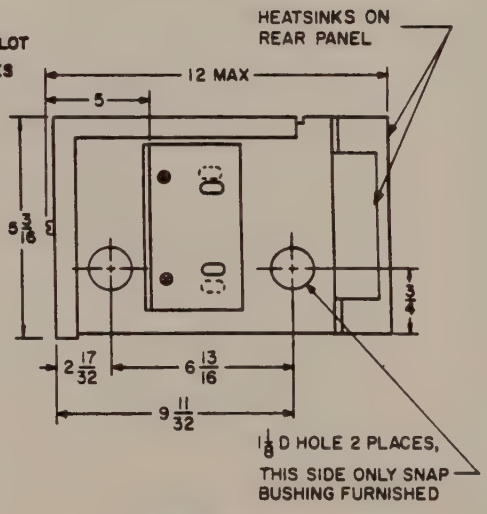
1. ALL DIMENSIONS ARE IN INCHES UNLESS OTHERWISE SPECIFIED.
2. WEIGHT
   (A) SHIPPING: 31 LBS.
   (B) NET: 26 LBS.
3. FINISH: EQUIPMENT LIGHT GRAY.
4. INDICATES VENTILATING GRILLE



TOP VIEW

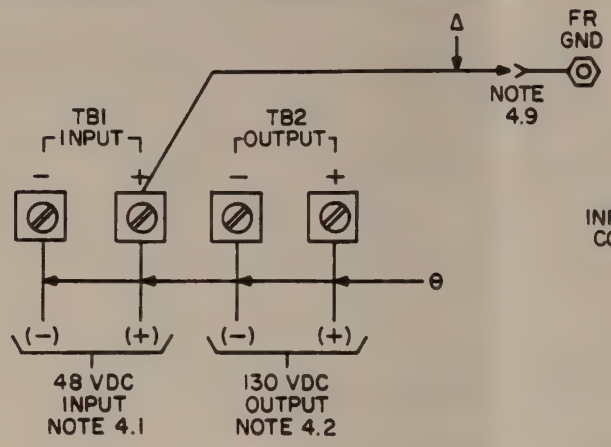


FRONT VIEW

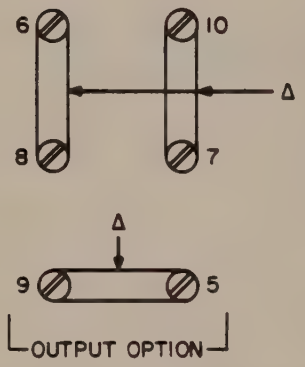


SIDE VIEW

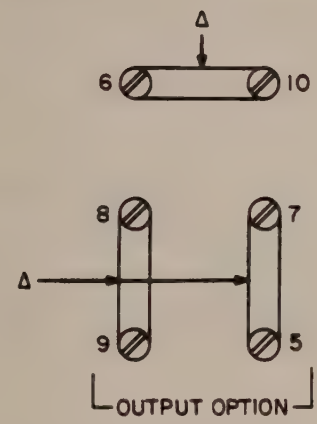
3. INSTALLER'S CONNECTIONS



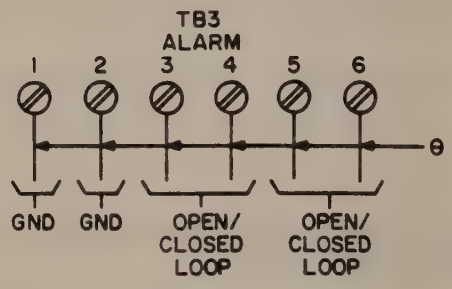
INPUT/OUTPUT
CONNECTIONS



(Y) OPTION
STRAPPING
(POSITIVE OUTPUT)



(Z) OPTION
STRAPPING
(NEGATIVE OUTPUT)



NOTE 4.6

ALARM OUTPUT
CONNECTIONS

NOTE 4.3

4. INSTALLER'S INFORMATION NOTES

4.1

DC INPUT (TB1)				
Terminals				
Capacity	Type	Loop Length - Ft	Recm Wire Size	Recm Fusing
14 to 6 Ga.	Saddle Clamp	39 62 98	10 Ga. 8 Ga. 6 Ga.	30 amperes

4.2

DC OUTPUT (TB2)			
Terminals			
Capacity	Type	Loop Length - Ft	Recm Wire Size
14 to 6 Ga.	Saddle Clamp	50 90 140	14 Ga. 12 Ga. 10 Ga.

4.3

ALARMS (TB3)		
Terminals		
Capacity	Type	Recm Wire Size
16 Ga. Max.	6-32 Screw	18 Ga.

4.4 DC wire sizes are sufficient to restrict the voltage drop to one volt or less at full rated current for the loop lengths shown. The loop length is the sum of the positive and negative leads.

4.5 Wire sizes based on recommendations of National Electric Code Table 310-16 for copper wire at 75 °C conductor temperature, operating in ambient of 30 °C. For operation in ambient higher than 30 °C, apply derating factors listed in Table 310-16 of National Electric Code.

4.6 An alarm condition within the converter connects ground at terminals 1 and 2 of TB3 and provides two closed loop circuits at terminals 3 to 4 and 5 to 6 of TB3.

4.7 △-indicates wiring furnished with the converter.

4.8 ⊖-indicates wiring furnished and installed by the customer.

4.9 Positive ground to chassis provided by jumper. Removal optional after installation. If grounding of converter chassis is required, connect 10 ga. wire from frame ground (FR GND) stud to earth ground.

CIRCUIT NOTES:

101. FUSES SHOWN IN THIS TABLE ARE NOT PART OF EQUIPMENT

DESIG	FUSE AMP	POTENTIAL	ONE PER
F1	10	250V	ASSEMBLY

BATTERY AND POWER SUPPLIES SYMBOLS

VOLTAGE RANGE 40-60

102. UNLESS OTHERWISE SPECIFIED THE FOLLOWING OPTION IS PROVIDED. Y

OPTION	REFERENCES	
	WIRING	CONNECT TB2 JUMPERS
POS OUTPUT	Y	5 TO 9, 6 TO 8, 7 TO 10
NEG OUTPUT	Z	5 TO 7, 6 TO 10, 8 TO 9

103. OPTIONAL FRAME GROUND FOR PROTECTION AGAINST REVERSE BATTERY POLARITY MAY BE REMOVED AFTER INSTALLATION.

EQUIPMENT NOTES:

201. REFER TO PD-5664-025 FOR EXTERNAL CONNECTIONS, FUSING AND WIRE SIZE.

INFORMATION NOTES:

301. UNLESS OTHERWISE SPECIFIED, RESISTANCE VALUES ARE IN OHMS, CAPACITANCE VALUES ARE MICROFARADS, AND VALUES PRECEDED BY THE SYMBOL + (PLUS), OR — (MINUS) ARE IN VOLTS.

302. CODES WITHIN PARENTHESES, AS (4864-248) REPRESENT LPC PART NUMBERS.

303. SEE WIRING DIAGRAM, T-5664-025 OR -027 FOR LORAIN PT. NO.S OF COMPONENTS.

304. HIGHEST REF DESIG. USED ON THIS DRAWING:

RES.	XMFR	DIODES	ASSYS	FUSES	CAP
R4	T5	CR1	A2	F1	C8
NOT USED					

REVISIONS

B		FEB 13 1982	NEW
1A	11-22-82	T.F.M	5664-027 ADDED
			CONVERSION TO LAMPS
B1	183935E	3-18-86	TJI CR13,14 MOVED OFF 4864-247 ASSY; C6-8, R2-4 ADDED

181-7162

FUNCTIONAL SCHEMATIC

FOR

DC-DC CONVERTER

MODEL HSB6H

DESIGN	G Georgalis	ECO 31
DRAWN BY	T F Maurer	DATE 12-15-8
CHECKED BY		DATE 2-15-82
CHECKED BY		DATE
APPROVED BY		DATE
RATING		

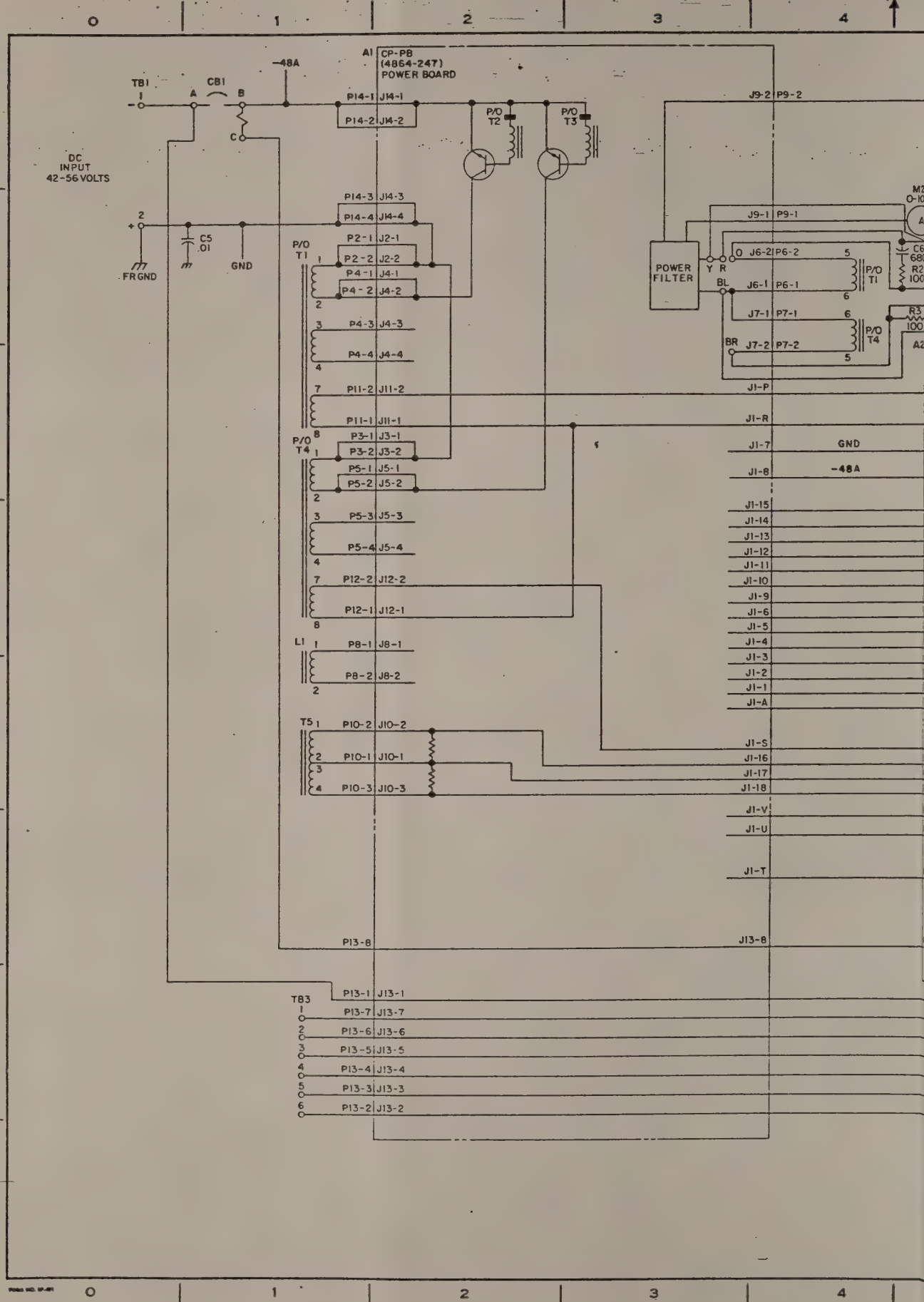
SD5664-027-00
SD5664-025-00

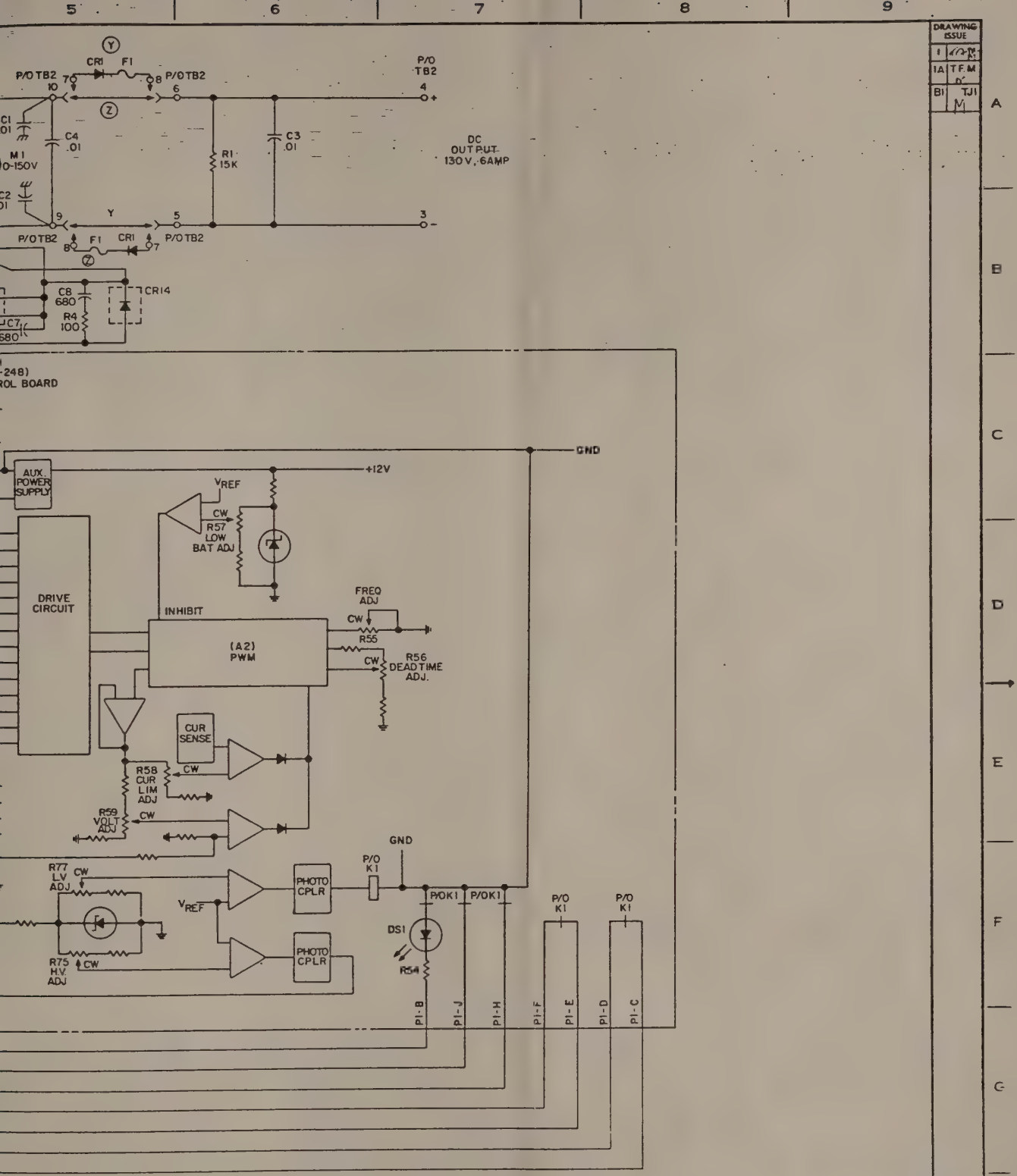
LORAIN PRODUCTS CORPORATION
LORAIN, OHIO
LORAIN PRODUCTS (CANADA) LTD., ST. THOMAS, ONTARIO

DWG SIZE D

SHEET 1 OF 2

PRINTED IN U.S.A.


A1 CP-P8 (4864-247) POWER BOARD
TB1
CB1
-48A
DC INPUT 42-56 VOLTS
FR GND
GND
C5 .01
P/O T2
P/O T3
P/O T1
P/O T4
L1
T5
POWER FILTER
TB3
P14-1 J14-1
P14-2 J14-2
P14-3 J14-3
P14-4 J14-4
P2-1 J2-1
P2-2 J2-2
P4-1 J4-1
P4-2 J4-2
P4-3 J4-3
P4-4 J4-4
P11-2 J11-2
P11-1 J11-1
P3-1 J3-1
P3-2 J3-2
P5-1 J5-1
P5-2 J5-2
P5-3 J5-3
P5-4 J5-4
P12-2 J12-2
P12-1 J12-1
P8-1 J8-1
P8-2 J8-2
P10-2 J10-2
P10-1 J10-1
P10-3 J10-3
P13-8 J13-8
P13-1 J13-1
P13-7 J13-7
P13-6 J13-6
P13-5 J13-5
P13-4 J13-4
P13-3 J13-3
P13-2 J13-2
J9-2 P9-2
J9-1 P9-1
J6-2 P6-2
J6-1 P6-1
J7-1 P7-1
J7-2 P7-2
J1-P
J1-R
J1-7 GND
J1-8 -48A
J1-15
J1-14
J1-13
J1-12
J1-11
J1-10
J1-9
J1-6
J1-5
J1-4
J1-3
J1-2
J1-1
J1-A
J1-S
J1-16
J1-17
J1-18
J1-V
J1-U
J1-T
J13-8



DRAWING ISSUE

1	
1A	T.F.M
B1	TJI

ISSUE 31

HSB6H
DC-DC CONVERTER

SD5664-027-00
SD5664-025-00

LORAIN PRODUCTS CORPORATION

DWG SIZE D

SHEET 2 OF 2

PRINTED IN U.S.A.

COMPONENT LIST

CAPACITOR

DESIG	CODE
(2) C1, C2	(2731-234) 1500 UF, 60 VDC, ELECT.
(2) C3, C4	(2731-180) 470 UF, 60 VDC, ELECT.
(2) C5, C6	(2731-650) 150 UF, 200 VDC, ELECT.
(2) C7, C8	(2715-131) 2.2 UF, 100 VDC
(4) C9, C10, C11, C12	(2715-125) 1 UF, 100 VDC
(2) C13, C14	(2713-423) 4700 PF, 600 VDC
(2) C15, C16 C17	(2724-160) 680 PF, 1000 VDC
(4) C19, C20, C21, C22	(2724-139) 1000 PF, 1000 VDC
(2) C23, C24	(2724-090) 0.1 UF, 100 VDC
(2) C18, C25	(2731-135) 50 UF, 75 VDC, ELECT.
	(2724-140) 0.01, 1000 VDC

DIODE

DESIG	CODE
(10) CR1-CR4, CR16-CR21	(2812-522) IN5402
(4) CR5, CR7, CR11, CR12	(2812-220) A114B
(2) CR6, CR8	(2835-217) 5.6V, 1W, ZENER
(4) CR9, CR10, 15, 22	(2813-008) A115B

INDUCTOR

DESIG	CODE
(2) L2, L3	(2428-703)

RESISTOR

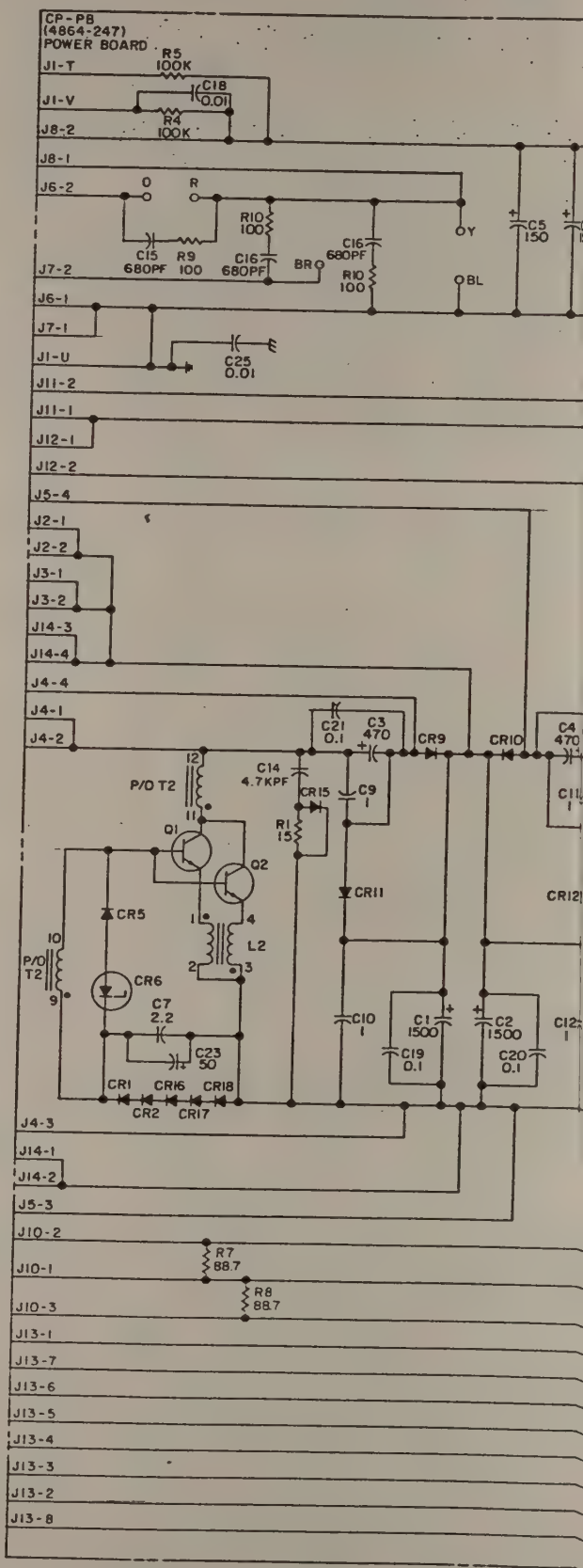
DESIG	CODE
(2) R1, R2 R3	(2651-311) 15 OHM, 3W, 5%
(2) R4, R5 R6	(2651-922) 10K, 5W, 5%
(2) R7, R8	(2634-696) 100K, 1/4W, 1%
(2) R9, R10	(2651-177) 510 OHMS, 3W, 5%
	(2635-547) 88.7 OHMS, 1W
	(2651-319) 100 OHMS, 3W, 5%

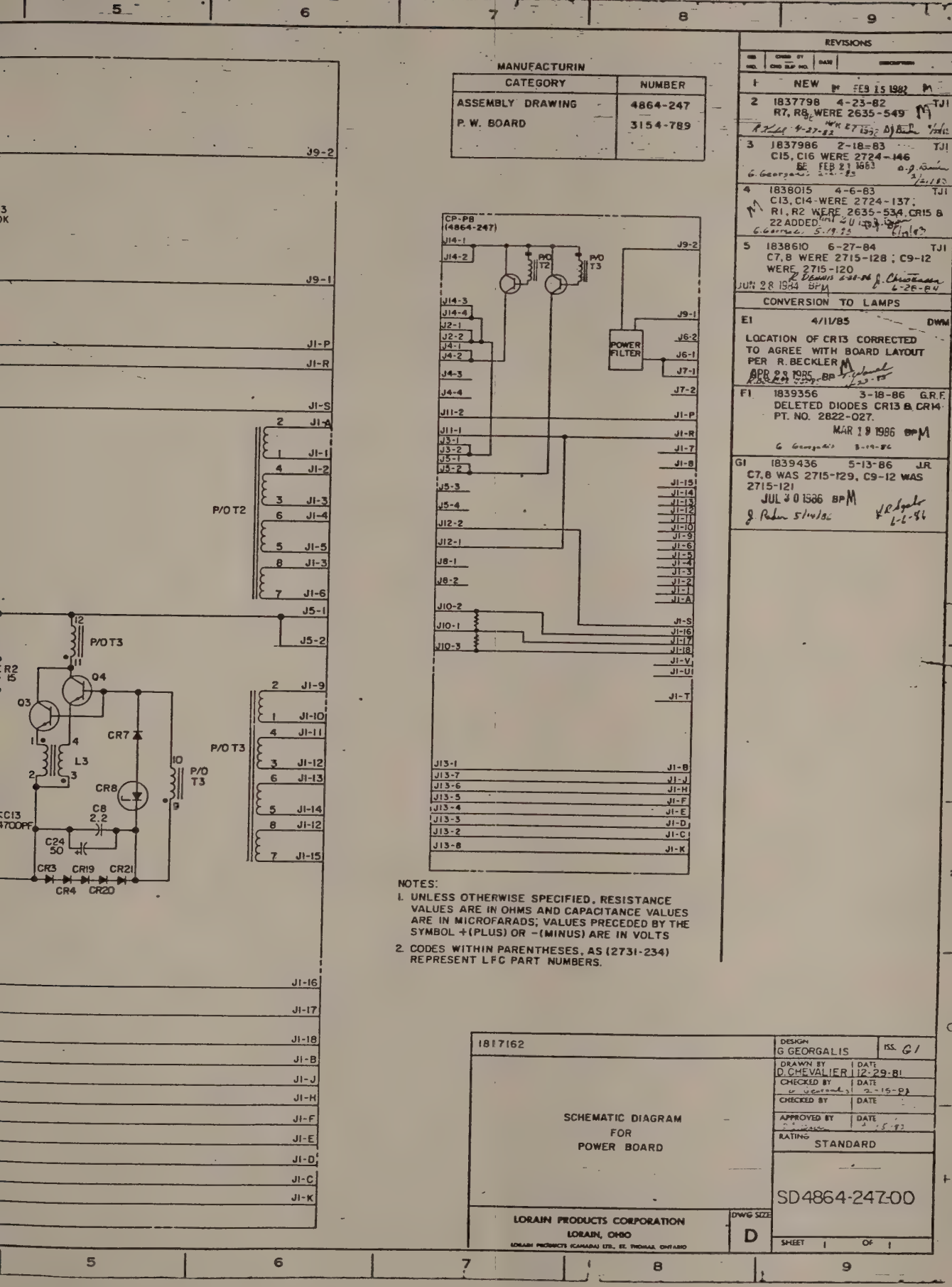
TRANSFORMER

DESIG	CODE
(2) T2, T3	(4481-036) DRIVE TRANSFORMER

TRANSISTOR

DESIG	CODE
(4) Q1-Q4	(2842-205)




MANUFACTURIN
CATEGORY
NUMBER
ASSEMBLY DRAWING
4864-247
P. W. BOARD
3154-789
REVISIONS
1 NEW
2 1837798 4-23-82 TJI
R7, R8 WERE 2635-549
3 1837986 2-18-83 TJI
C15, C16 WERE 2724-146
4 1838015 4-6-83 TJI
C13, C14 WERE 2724-137;
R1, R2 WERE 2635-534, CR15 & 22 ADDED
5 1838610 6-27-84 TJI
C7,8 WERE 2715-128 ; C9-12 WERE 2715-120
CONVERSION TO LAMPS
E1 4/11/85 DWM
LOCATION OF CR13 CORRECTED TO AGREE WITH BOARD LAYOUT PER R. BECKLER
F1 1839356 3-18-86 G.R.F.
DELETED DIODES CR13 & CR14 PT. NO. 2822-027.
G1 1839436 5-13-86 J.R.
C7,8 WAS 2715-129, C9-12 WAS 2715-121
CP-P8 (4864-247)
P/O T2
P/O T3
POWER FILTER
J9-2
J9-1
J1-P
J1-R
J1-S
J1-A
J1-1
J1-2
J1-3
J1-4
J1-5
J1-6
J5-1
J5-2
J1-9
J1-10
J1-11
J1-12
J1-13
J1-14
J1-15
J1-16
J1-17
J1-18
J1-B
J1-J
J1-H
J1-F
J1-E
J1-D
J1-C
J1-K
J6-2
J6-1
J7-1
J7-2
J1-7
J1-8
J1-15
J1-14
J1-13
J1-12
J1-11
J1-10
J1-9
J1-6
J1-5
J1-4
J1-3
J1-2
J1-1
J1-A
J1-V
J1-U
J1-T
Q3
Q4
CR7
CR8
L3
C8 2.2
C24 50
CR3
CR19
CR21
CR4
CR20
NOTES:
1. UNLESS OTHERWISE SPECIFIED, RESISTANCE VALUES ARE IN OHMS AND CAPACITANCE VALUES ARE IN MICROFARADS; VALUES PRECEDED BY THE SYMBOL +(PLUS) OR -(MINUS) ARE IN VOLTS
2. CODES WITHIN PARENTHESES, AS (2731-234) REPRESENT LFC PART NUMBERS.
1817162
SCHEMATIC DIAGRAM FOR POWER BOARD
DESIGN G GEORGALIS
ISS. G1
DRAWN BY D CHEVALIER 12-29-81
CHECKED BY 2-15-82
RATING STANDARD
SD4864-247-00
LORAIN PRODUCTS CORPORATION LORAIN, OHIO
DWG SIZE D
SHEET 1 OF 1

COMPONENT LIST

CAPACITORS

	DESIG	CODE
(4)	C1,2,3,5	(2731-135) 50 UF,75VDC,ELECT.
(9)	C6,7,10,11,14,16,21,4,22	(2724-509) 100K PF,50VDC
(2)	C8,20	(2737-134) 10 UF,20VDC,TANT.
	C9	(2731-132) 100 UF,25VDC,ELECT.
	C12	(2713-115) 0.0047 UF,200VDC
	C13	(2713-208) 0.0033UF,200 VDC
	C15	(2724-101) 15PF, 500VDC
	C17	(2724-536) 270 PF,1000VDC
(2)	C18,24	(2715-125) 1 UF,100VDC
	C19	(2731-060) 4.7 UF,50VDC,ELECT.
	C25	(2724-560) 3300PF,50VDC

DIODES

DESIG	CODE
CR1	(2836-212) 1N4742A
(17) CR2-5,9-12,14,15,18, 19,21,25,33,37,13	(2811-101) 1N4148
(2) CR6,39	(2834-412) 1N4729
(2) CR7,8	(2812-204)
(9) CR16,17,20,23,24 28,29,30,38	(2812-220)
(2) CR22,27	(2835-325) 1N823
(3) CR26,31,32	(2812-522) 1N5402
DSI	(2818-125)
CR34	(2836-116)

INDUCTORS

DESIG	CODE
(2) L1,2	(2413-110) CHOKE

RELAYS

DESIG	CODE
K1	(2543-443)

RESISTORS

DESIG	CODE
R1	(2651-198) 2.4K,3W,5%
R2	(2634-644) 8.25K,1/4W,1%
(13) R3,9,10,19,20,24,30, 31,35,37,47,80,82,	(2634-632) 4.75K,1/4W
R36	(2668-601) RESISTOR JUMPER,0 OHM
R4	(2634-670) 27.4K ,1/4W,1%
R5	(2651-343) 2.7K,3W,5%
R6	(2651-302) 1 OHM,3W,5%
R7	(2637-225) 10K,1/2W,5%
(3) R43,52,69	(2634-752) 1.5 MEGO,1/4W,1%
(9) R11,12,21,22,32,33, 45,70,74	(2634-605) 1.5K,1/4W,1%
(2) R13,14	(2635-560) 169 OHM,1W,1%
(4) R15,16,26,27	(2615-231) 47 OHM,1/2W
(6) R17,18,23,28,29,34	(2615-257) 560 OHM,1/2W
(3) R25,36,61	(2634-627) 3.92K,1/4W,1%
R40	(2634-642) 7.5K,1/4W,1%
(4) R41,76,78,87	(2634-614) 2.21K,1/4W,1%
(2) R42,89	(2615-335) 1 MEGO,1/2W
(6) R44,48,64,86,93,60	(2634-648) 10K,1/4W,1%
R49	(2634-696) 100K,1/4W,1%
R53	(2634-662) 18.2K,1/4W,1%
R54	(2615-476) 5.6K,1W
(3) R55,57,58	(2675-117) 5K,1/2W,POT
R59	(2675-113) 1K,1/2W,POT
R39	(2634-634) 5.11K,1/4W,1%
(2) R62,88	(2634-664) 20.5K,1/4W,1%
R63	(2634-623) 3.32K,1/4W,1%
R65	(2634-714) 221K,1/4W,1%
(3) R66,67,81	(2634-670) 27.4K,1/4W,1%
(2) R68,83	(2634-657) 16.9K,1/4W,1%
R71	(2634-601) 1.21K,1/4W,1%
R72	(2634-652) 12.1K,1/4W,1%
R73	(2634-693) 82.5K,1/4W,1%
(2) R75,77	(2675-114) 2K,1/2W,POT
R79	(2634-590) 681 OHM,1/4W,1%
R84	(2634-619) 2.74K,1/4W,1%
(2) R46,85	(2634-597) 1.0K ,1/4W,1%
(2) R90,91	(2651-171) 390 OHM,3W
R56	(2675-120) 10K,1/2W POT
R50	(2634-548) 49.9 OHM,1/4W

TRANSFORMER

DESIG	CODE
T1	(4471-050)
T2	(4411-159)

TRANSISTORS

DESIG	CODE
Q1	(2842-071) 2N6292
Q2	(2841-155) 2N2102
Q3	(2842-058)
(3) Q4,22,23	(2841-102) 2N699
Q5	(2843-151) 2N4036
(6) Q8,11,15,16,19,20	(2841-061) 2N3904
(3) Q7,10,21	(2843-056) 2N3906
(2) Q9,12	(2841-185) NPN, 2N3506
(4) Q13,14,17,18	(2844-044) MJE250

INTEGRATED CIRCUITS

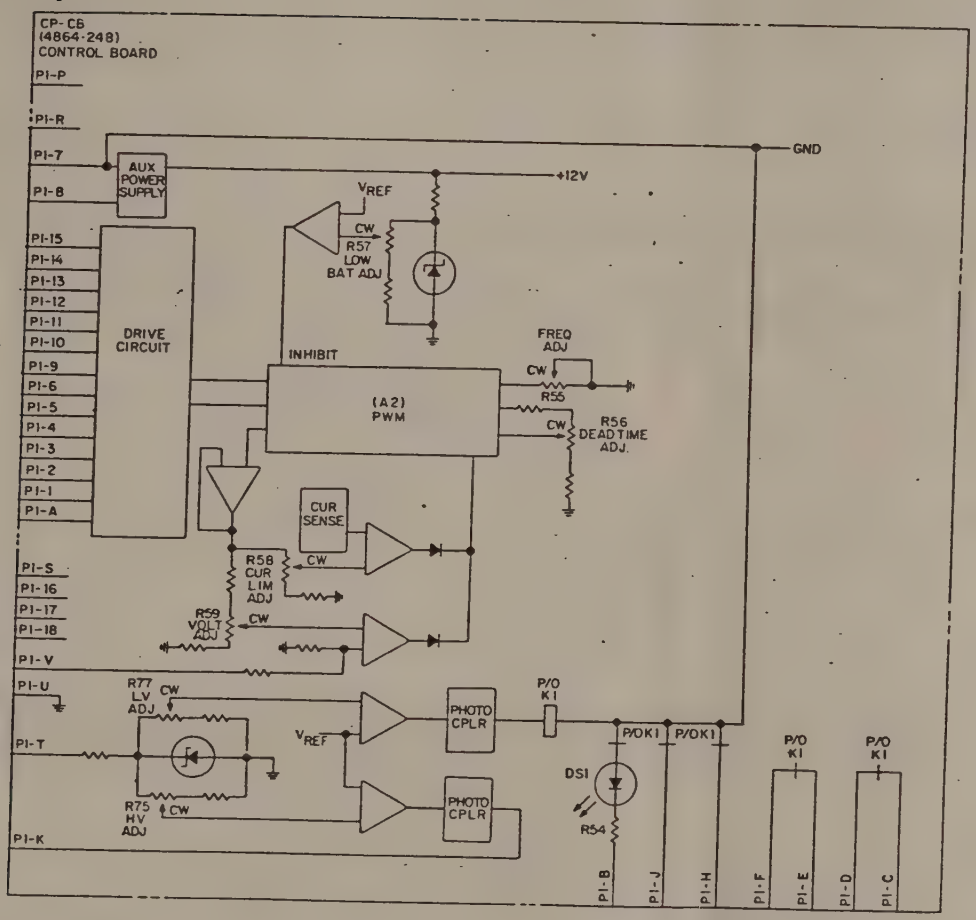
DESIG	CODE
A1	(2871-309) VOLT REG
A2	(2873-115) REGULATOR
A3	(2871-115) OP-AMP
A4	(2871-205) COMPARATOR
(2) A5,6	(2857-101) PHOTO COUPLER
A7	(2871-001) TIMER

REVISIONS			
NO.	CHGD BY / CHG SLIP NO.	DATE	DESCRIPTION
1			NEW BP FEB 16 84
2	1837798	4-23-82	TJ R90 WAS 2634-557 MAY 27 1982 BP
3	1837811	5-25-82	T.F.M. SH.2, R62 WAS 27.4K;
4	1837817	6-26-82	T.F.M. C4 ADDED. JUN 24 1982 BP
5	1837850	8-17-82	T.F.M. C22 ADDED, R56 WAS 5K, R38 WAS 4.75K AUG 20 1982 BP
6	1837877	11-23-82	T.F.M R50 ADDED, 3156-211 WAS 3154-781 R90 WAS 2634-567. NOV 24 1982 BP
7	1838192	7-27-83	T.F.M R39 & C13 WERE 2634-627 & 2713-115 RESP. JUL 28 1983 BP
8	1838076	2-15-84	TJI C18 WAS 2715-120 FEB 21 1984 BP
9	1838410	4-17-84	T.F.M. C12,17,18,CR13,R50,90,91 & 94 WERE 2713-208,2724-140,2715-120, 2812-220,2634-696,2634-582,2634-632 & 2634-632 RESP. C24,25,CR34,39 & T2 ADDED. R92,06,24 & A8 REMOVED. 3156-221 WAS 3156-21 APR 19 1984 BP
CONVERSION TO LAMPS			
K1	1839080	8-12-85	J.R. Q9 & Q12 WERE 2841-145. AUG 15 1985 BP
L1	1839436	5-14-86	J.R. C18 & C24 WAS 2715-121 JUL 30 1986 BP

MANUFACTURING REFERENCES

CATEGORY	NUMBER
ASSEMBLY DRAWING	4864-248
P.W. BOARD	3156-221
CONNECTOR ON FRAME	

SYMBOL



TES:

1. UNLESS OTHERWISE SPECIFIED RESISTANCE VALUES ARE IN OHMS AND CAPACITANCE VALUES ARE IN MICROFARADS; VALUES PRECEDED BY THE SYMBOL + (PLUS),OR - (MINUS) ARE IN VOLTS.
2. CODES WITHIN PARENTHESES,AS (2731-135) REPRESENT LPC PT NUMBERS.

181-7162

SCHEMATIC DIAGRAM
FOR
CONTROL BOARD

MODEL HSB6H

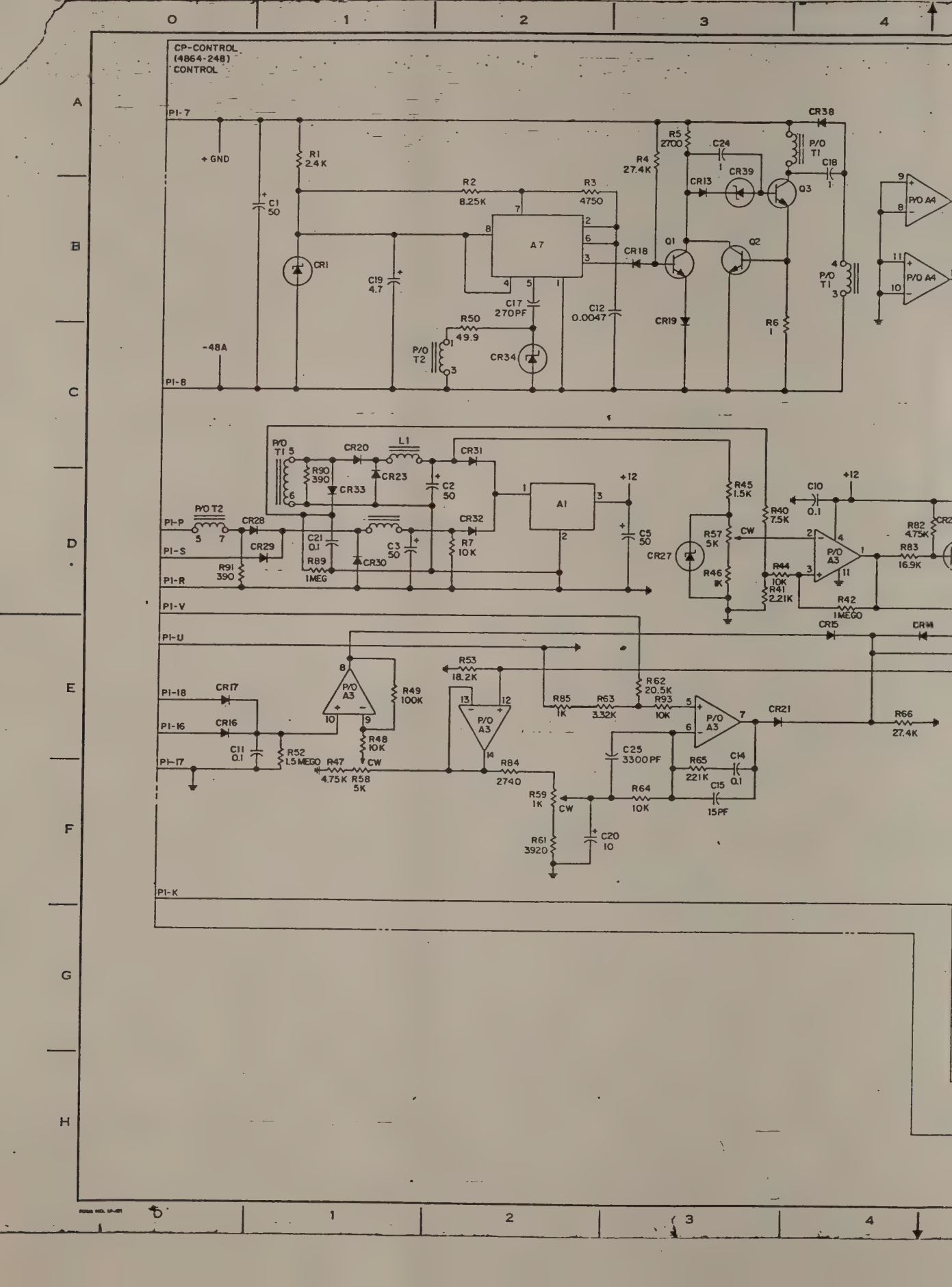
DESIGN	G Georgalis	ECS 21
DRAWN BY	T Maurer	DATE 12-29-81
CHECKED BY	G Georgalis	DATE 2-15-82
CHECKED BY		DATE
APPROVED BY		DATE
RATING		

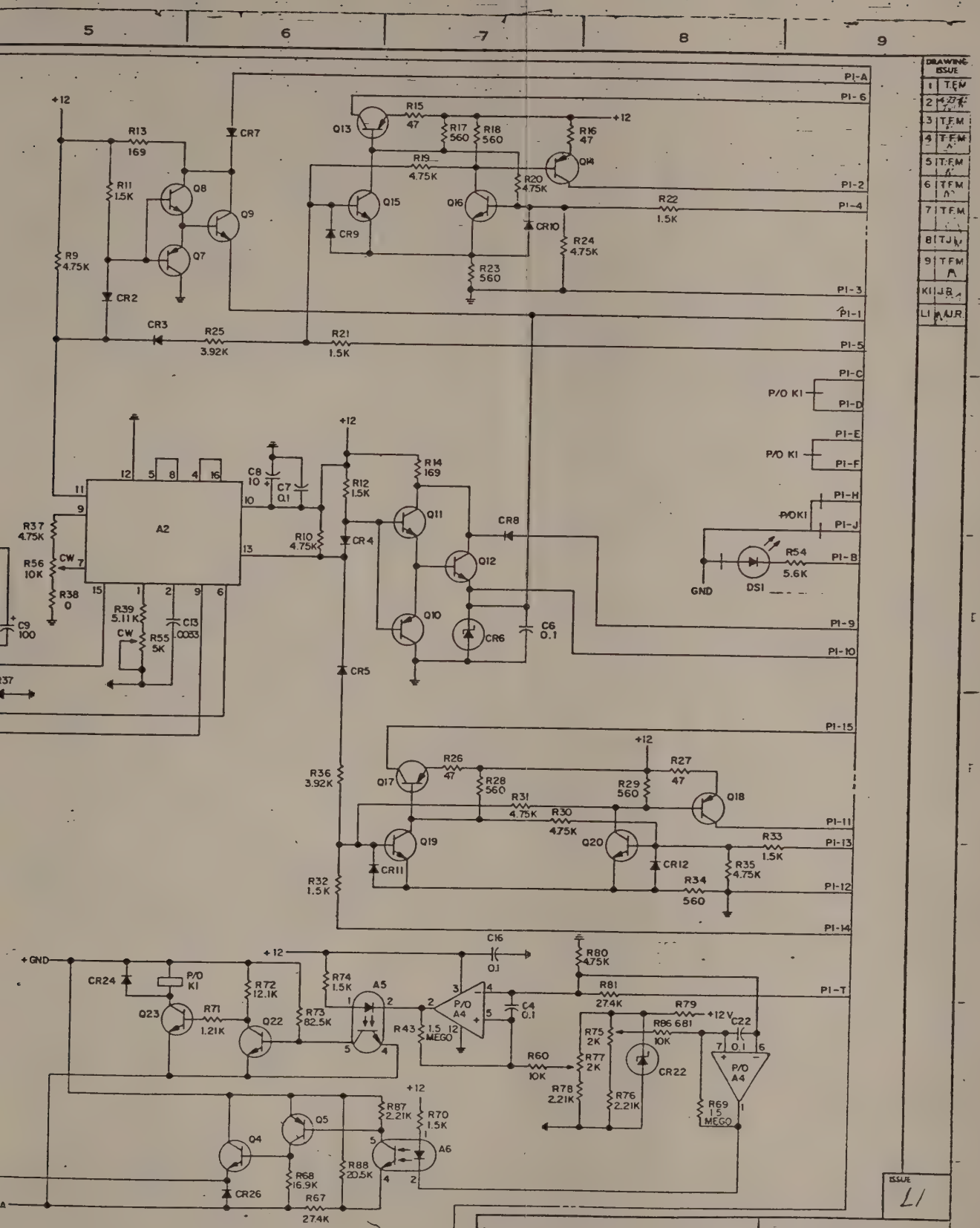
LORAIN PRODUCTS CORPORATION
LORAIN, OHIO
LORAIN PRODUCTS (CANADA) LTD., ST. THOMAS, ONTARIO

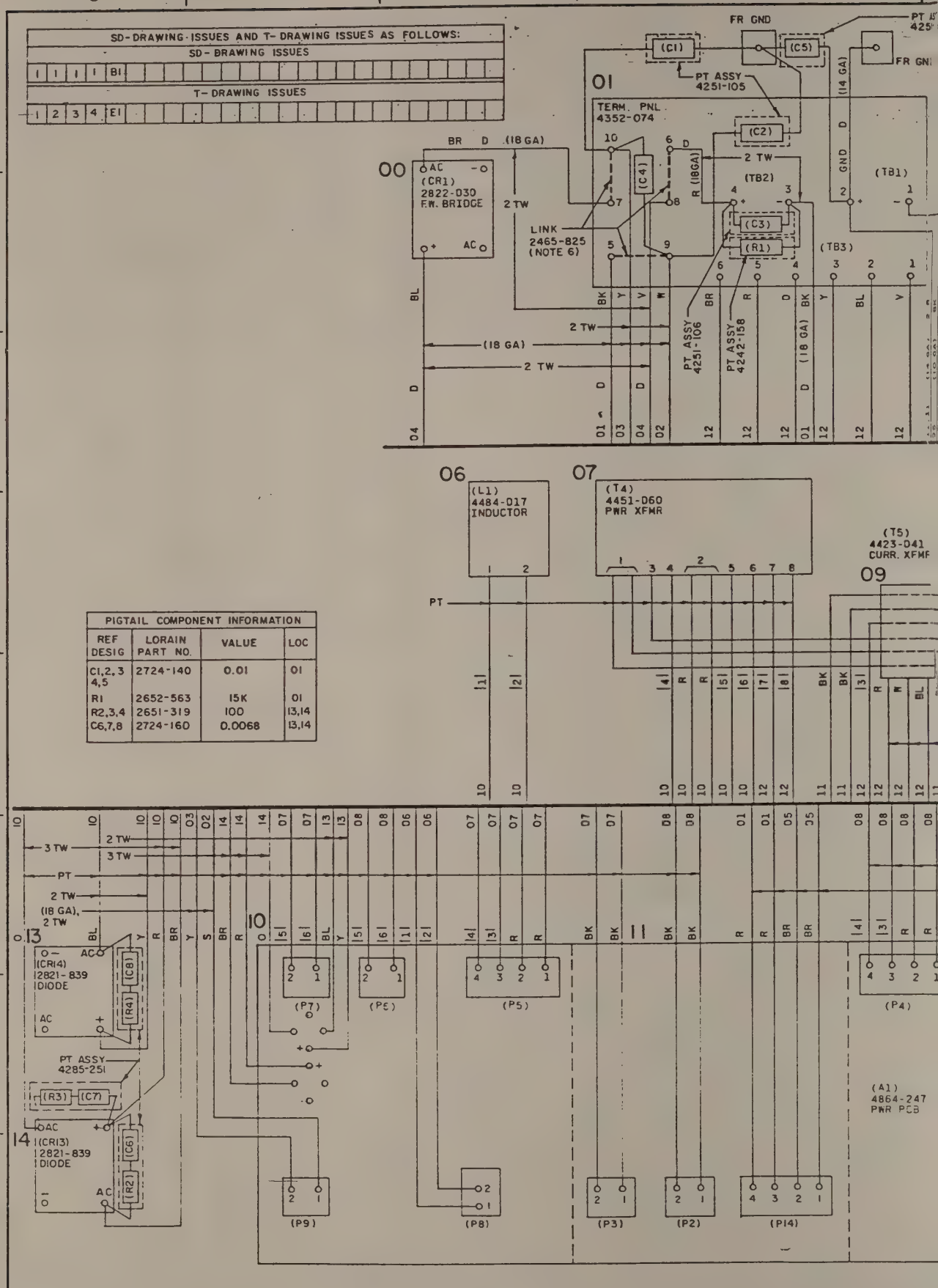
DWG SIZE D

SD4864-248-00

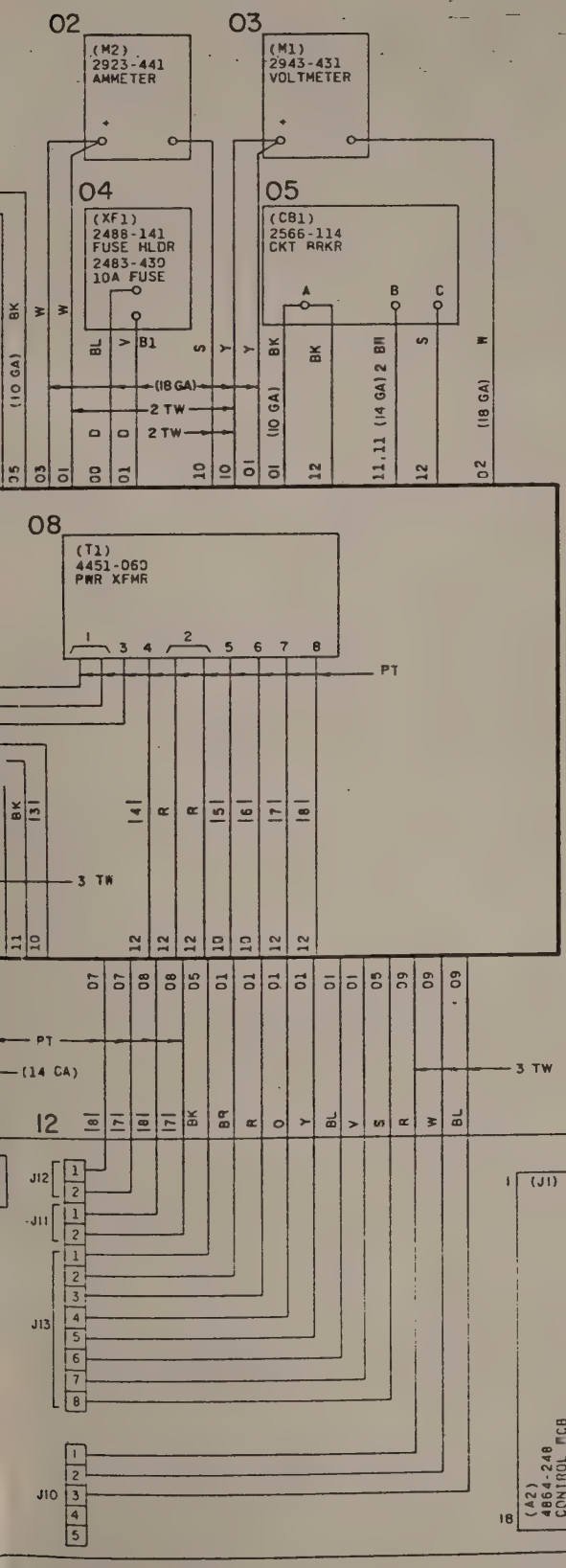
SHEET 1 OF 2


CP-CONTROL
(4864-248)
CONTROL
P1-7
+GND
R1
2.4K
C1
50
R2
8.25K
R3
4750
A7
R4
27.4K
R5
2700
C24
CR38
P/O T1
C18
CR13
CR39
Q3
CR18
Q1
Q2
CR1
C19
4.7
C17
270PF
C12
0.0047
CR19
R6
1
R50
49.9
P/O T2
CR34
-48A
P1-8
P/O A4
P/O A4
P/O T1 5
CR20
L1
CR31
R90
390
CR33
CR23
C2
50
A1
+12
C5
50
P/O T2
P1-P
CR28
CR32
C21
0.1
C3
50
R7
10K
P1-S
CR29
R91
390
R89
1MEG
CR30
P1-R
R45
1.5K
C10
0.1
+12
R40
7.5K
R57
5K
CW
CR27
R46
1K
R44
10K
R41
2.21K
P/O A3
R82
4.75K
R83
16.9K
R42
1MEGO
P1-V
P1-U
CR15
CR14
P1-18
CR17
P1-16
CR16
P1-17
C11
0.1
R52
1.5 MEGO
R47
4.75K
R58
5K
CW
P/O A3
R49
100K
R48
10K
R53
18.2K
P/O A3
R84
2740
R85
1K
R63
3.32K
R62
20.5K
R93
10K
P/O A3
CR21
R66
27.4K
C25
3300 PF
R65
221K
C14
0.1
C15
15PF
R64
10K
R59
1K
CW
R61
3920
C20
10
P1-K


+12
R13 169
CR7
R11 1.5K
Q8
Q9
Q7
R9 4.75K
CR2
CR3
R25 3.92K
R21 1.5K
Q13
R15 47
R17 560
R18 560
R16 47
R19 4.75K
Q14
R20 4.75K
Q15
Q16
R22 1.5K
CR9
CR10
R24 4.75K
R23 560
P1-A
P1-6
P1-2
P1-4
P1-3
P1-1
P1-5
P1-C
P/O K1
P1-D
P1-E
P/O K1
P1-F
P1-H
P/O K1
P1-J
P1-8
R54 5.6K
DS1
GND
A2
C8 10
C7 0.1
R12 1.5K
R14 169
Q11
Q12
Q10
CR6
C6 0.1
CR8
CR4
R10 4.75K
R37 4.75K
R56 10K
CW
R38 0
C9 100
R39 5.11K
C13 .0033
R55 5K
CR5
P1-9
P1-10
P1-15
R36 3.92K
+12
R26 47
R27 47
Q17
R28 560
R29 560
Q18
R31 4.75K
R30 475K
Q19
Q20
R33 1.5K
CR11
CR12
R35 4.75K
R32 1.5K
R34 560
P1-11
P1-13
P1-12
P1-14
+GND
CR24
P/O K1
R72 12.1K
R74 1.5K
A5
C16 0.1
R80 475K
P1-T
Q23
R71 1.21K
Q22
R73 82.5K
R43 1.5 MEGO
P/O A4
C4 0.1
R81 27.4K
R79
+12V
C22
R86 681
10K
R75 2K
R77 2K
CR22
R60 10K
R78 2.21K
R76 2.21K
R69 1.5 MEGO
Q5
Q4
R87 2.21K
R70 1.5K
A6
R68 16.9K
R88 20.5K
CR26
R67 27.4K
DRAWING ISSUE
1 T.F.M
2 T.F.M
3 T.F.M
4 T.F.M
5 T.F.M
6 T.F.M
7 T.F.M
8 T.J.W
9 T.F.M
K1 J.B.
L1 A.U.R.
ISSUE L1
SD4864-248-00
LORAIN PRODUCTS CORPORATION
DWG SIZE D
SHEET 2 OF 2
PRINTED IN U.S.A.



PIGTAIL COMPONENT INFORMATION			
REF DESIG	LORAIN PART NO.	VALUE	LOC
C1,2,3 4,5	2724-140	0.01	01
R1	2652-563	15K	01
R2,3,4	2651-319	100	13,14
C6,7,8	2724-160	0.0068	13,14



NOTES:

1. ALL WIRING TO BE 22 GA. UNLESS OTHERWISE SPECIFIED.
2. D-INDICATES LEAD IS A JUMPER.
3. B1-TERMINAL NEAREST MOUNTING SURFACE.
4. 11.12.13 -INDICATES WIRE LABELS.
5. 2 TW, 3 TW = TWO, THREE WIRES SHALL BE TWISTED TOGETHER.
6. (Y) OPTION IS STANDARD
7. UNLESS OTHERWISE SPECIFIED, RESISTANCE VALUES ARE IN OHMS, CAPACITANCE VALUES ARE IN MICROFARADS.

REVISIONS

ECO NO.	CHKD BY / CHG SUP. NO.	DATE	DESCRIPTION
1			NET
2	1837766	3-27-82	J.R. PIGTAIL ASSY NO'S ADDED J.A. Stipe 3-31-82
3	1837860	8-17-82	J.R. PIGTAIL 'C5' WAS 4251-105, NOW 4251-138 J.A. Stipe 8-19-82
3A		11-22-82	T.F.M. 5664-027 ADDED
4	1838309	12-6-83	J.R. BK & RED LEADS AT T1 & T4 AT LOC 07 & 08 WERE LABELED 11 & 12
			CONVERSION TO LAMPS
E1	1839356	3-18-86	J.R. CR13 & 14 AND ASSOCIATED WIRING ADDED Tim Sheeley 3-19-86 A. Marcucci 4/17/86

181-7162

WIRING DIAGRAM
FOR
DC DC CONVERTER
MODEL HSB6H

LORAIN PRODUCTS CORPORATION
LORAIN, OHIO
LORAIN PRODUCTS (CANADA) LTD., ST. THOMAS, ONTARIO

DWG SIZE D

DESIGN S. MALESKY ISS. E
DRAWN BY [illegible] DATE 12-10-81
CHECKED BY DATE
CHECKED BY DATE
APPROVED BY DATE
RATING STANDARD

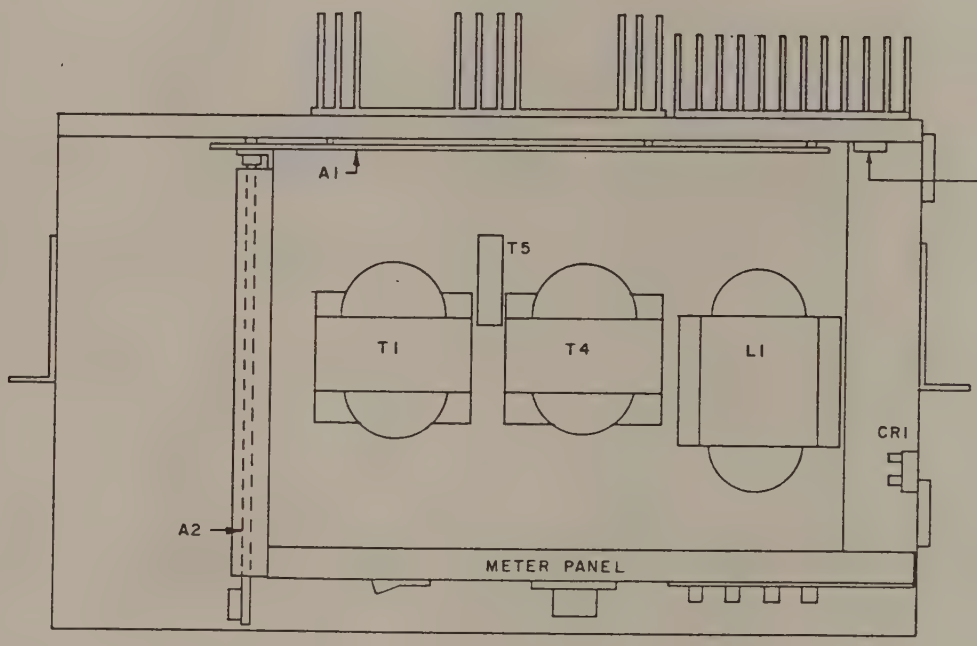
T-5664-027-00
T-5664-025-00

SHEET 1 OF 2

FIG. 2

PARTS LOCATION

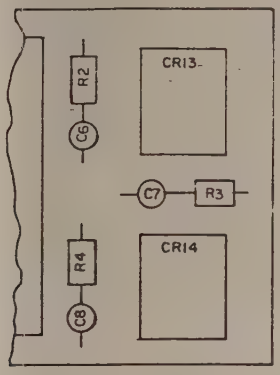
TOP VIEW



5 6 7 8 9

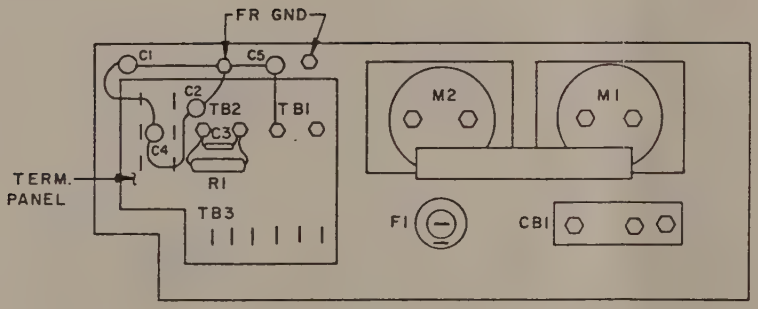
DRAWING ISSUE	
1	
2	
3	
3A	TFM
4	
E1	JR

INSIDE BACK PANEL



R13,14
EE INSIDE BACK PANEL

INSIDE METER PANEL



ISSUE E1

HSB6H	T-5664-027-00 T-5664-025-00
LORAIN PRODUCTS CORPORATION — DWG SIZE D	SHEET 2 OF 2 PRINTED IN U.S.A.

5 6 7 8 9

FOR PARTS OR SERVICE, CONTACT THE NEAREST

LORAIN REGIONAL SERVICE CENTER

OHIO REGIONAL SERVICE CENTER
1313 G Street
Lorain, Ohio 44052
Telephone: 216/288-1122

TEXAS REGIONAL SERVICE CENTER
722 N. Great Southwest Parkway
Arlington, Texas 76011
Telephone: 817/640-1134

CONNECTICUT REGIONAL SERVICE CENTER
9-A Old Windsor Road
Bloomfield, Connecticut 06002
Telephone: 203/726-1990

SOUTHERN CALIFORNIA REGIONAL SERVICE CENTER
3001 Red Hill, Bldg. 6, Suite 109
Costa Mesa, California 92626
Telephone: 714/540-4395

ILLINOIS REGIONAL SERVICE CENTER
245 Roosevelt Road, Bldg. 7, Unit 49, 50
West Chicago, Illinois 60185
Telephone: 312/231-5775

NORTHERN CALIFORNIA REGIONAL SERVICE CENTER
2075 O'Toole Ave.
San Jose, California 95131
Telephone: 408/435-1303

GEORGIA REGIONAL SERVICE CENTER
5555 Oakbrook Parkway, Suite 540
Norcross, Georgia 30093
Telephone: 404/449-0840

CANADIAN SERVICE CENTER
122 Edward Street
St. Thomas, Ontario
Telephone: 519/631-0780

COLORADO REGIONAL SERVICE CENTER
4010 Youngfield St.
Wheat Ridge, Colorado 80033
Telephone: 303/422-6213

PACIFIC NORTHWEST SERVICE CENTER
15247 N.E. 90th Street
Redmond, Washington 98052
Telephone: 206/883-7912

LORAIN SERVICE® CAN ALSO PROVIDE:

Audio Visual Training Programs (Slide/Cassette)

- Battery Charger Maintenance - No. L302AV
- Storage Battery Maintenance - No. L301AV
- Central Office Ground Maintenance - No. L401AV

Factory or On-Site Training School

Specialized Test Equipment

- Ringing Generator Test Set - Model LS2000
  (Includes loads, metering, digital frequency counter)
- 130V Converter Test Load - Model LS1000
  (Variable loads to 6 amps)

Power Evaluation Program (PEP)

- Power analysis program for all central office power equipment including batteries.

Power Upgrade and Modernization Services

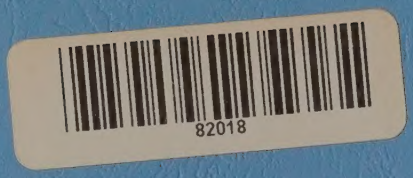
- Including engineering, fabrication and complete installation

Maintenance Contracts

Spare Parts Kits and Fuse Kits

Handy and practical, helps keep down time to a minimum.

Contact your nearest LORAIN Regional Service Center for more information.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